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COMMERCIAL ASPECTS OF THE JAPAN-CHINA WAR.

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IT is more than probable that the war now in progress between Japan and China, the two largest empires of Asia, will be of long duration and of serious consequences. It may last for years. It may lead to a general complication with European nations,—particularly those which have large commercial or territorial interests in the east, and especially England and Russia. Russia wants a foothold in Corea in order to establish her supremacy in the Pacific. The present headquarters of Russia in the Pacific coast are at Vladivostock, which, while possessing a magnificent harbor, is altogether too cold in winter; during several months of the year no ships can move in or out on account of its ice-bound condition. Russia wants Port Lazareff on the eastern coast of Corea to make it the terminus of her great Siberian railway, as well as the headquarters of her military and naval forces on the Pacific coast. But England will not, under any circumstances, allow Russia to assert her power in that part of the world without a bitter contest, for in that case the British supremacy in the east would be a thing of the past.

The United States, under a wide construction of the "Monroe doctrine," will not allow itself to be led into an entanglement in this instance. What concerns the American people most, therefore, is not the political effect of the hostilities which are raging between Japan and China,—whose object is, on either side, to destroy lives and property of the enemy,—but the effect which this war may have upon the "peaceful commercial warfare" which is carried on for mutual benefit and advantage by the United States with both Japan and China.

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Let us examine the quantity and the quality of the trade now done between the United States and the two belligerent nations. The official report of the bureau of statistics of the treasury department at Washington for the fiscal year 1892–93 gives the following figures:

IMPORTS FROM JAPAN—FISCAL YEAR 1892–93.

Camphor, crude	$ 302,349
Sulphur, crude	133,455
Chemicals, drugs, and dyes	58,032
Hats, bonnets and hoods, material for	119,286
Paper stock, crude	113,993
Silk, unmanufactured, raw and waste	14,791,633
Tea	5,699,582
Coal, bituminous	8,544
Earthen, stone, and china ware	407,109
Flax, hemp, jute, etc., manufactures of	64,408
Metal compositions and manufactures of	92,848
Paper and manufactures of	310,986
Rice and rice meal	324,412
Silk, manufactures of	3,347,834
Wood, manufactures of	140,974
All other articles	1,538,775
Total merchandise	$27,454,220
Specie—Gold	89,274
Silver	2,407
Total merchandise and specie	$27,545,901

EXPORTS TO JAPAN—FISCAL YEAR 1892–93.

Books, maps, engravings, etc	$ 16,790
Breadstuffs—Wheat flour	193,945
Chemicals, drugs, dyes, and medicines	20,514
Clocks and watches and parts of	114,694
Cotton cloth	9,084
Fruits, preserved	11,813
Iron and steel and manufactures of	88,314
Machinery	104,954
Leather—Sole	147,071
Oils—Mineral refined	1,724,972
Provisions, comprising meat and dairy products	68,050
Stationery, except paper	14,174
Tobacco, manufactures of	232,662
Wood, manufactures of	63,268
All other articles	379,406
Total domestic merchandise	$3,189,711
Foreign merchandise	5,783
Specie—Silver	4,150,980
Total merchandise and specie	$ 7,346,474

IMPORTS FROM CHINA—FISCAL YEAR 1892-93.

Chemicals, drugs, and dyes	$ 136,455
Coffee	262,236
Farinaceous substances, etc.	13,510
Hats, bonnets, and hoods, materials for	405,329
Hides and skins, other than fur skins	464,149
Mattings for floors, of round or split straw	755,679
Silk, unmanufactured, raw and waste	5,470,380
Spices, unground	118,874
Tea	7,413,984
Opium prepared for smoking, etc.	473,517
Cotton, manufactures of	41,272
Earthen, stone, and china ware	16,242
Fish	30,502
Fruits, preserved	19,727
Furs, and manufactures of	512,382
Leather, and manufactures of	333,010
Paper and manufactures of	24,800
Provisions, meat products	33,384
Rice	528,408
Seeds	6,841
Silk, manufactures of	338,659
Spirits, distilled	19,778
Tobacco, manufactures of	38,666
Vegetables	65,702
Wood, manufactures of	54,926
Wools and manufactures of	25,565
Wools, unmanufactured	1,812,250
All other articles	1,220,380
Total merchandise	$20,636,535
Specie—Gold	129,360
Total merchandise and specie	$20,765,895

EXPORTS TO CHINA—FISCAL YEAR 1892-93.

Breadstuffs—Wheat-flour	$ 66,699
Clocks and watches, and parts of	16,578
Cotton cloths	1,638,657
Iron and steel and manufactures of	52,431
Leather and manufactures of	7,542
Oil, mineral, refined	1,809,437
Provisions, comprising meat and dairy products	25,942
Tobacco, manufactures of	76,749
Wood, boards, deals, and planks	80,718
All other articles	125,694
Total merchandise	$3,900,457
Specie—Silver	50,000
Total merchandise and specie	$3,950,457

It thus appears that the commerce of the United States with China and Japan is one-sided. We buy largely from both countries, but sell little to either. They can buy cheaper from Europe than from us, while we are compelled to buy from them by the fact that most of the commodities are procurable only from those countries. Some classes of goods which are obtainable elsewhere can be sold to us for less money by China or Japan than by other countries. The most important articles imported from Japan are silk (raw and manufactured) and tea, which amount to more than 80 per cent. of the total imports from that country. Our shipment of petroleum heads the list, and this is the only article of considerable value going in that direction. Our export to China amounts to a little less than $4,000,000,—with kerosene and cotton cloths as the principal commodities,—but she supplies us with goods worth over $20,000,000, tea and silk being the chief articles, as in the case of Japan.

Now as to the quality of goods imported from Japan and China. The principal articles are raw silk and tea, which cannot be produced so cheaply in the United States. Tea is peculiar to those countries, for climatic reasons, while the quality of silk goods imported from Japan is such that American looms cannot duplicate them.

The volume and character of the imports of China and Japan from the United States show the higher state of civilization and greater development of manufacturing in Japan as compared with China. China, having a population ten times larger than her neighbor, buys of us very little more than the latter, while falling far short with respect to exports. The imports of Japan are larger in each item, except in the case of kerosene and cotton cloth. With regard to cotton cloth the cause is plain. Japan has of late years built numerous spinning factories, and not only can supply its own wants, but is supplying China with cotton yarns. With China, books, maps, engravings, stationery, musical instruments, etc., are so insignificant that the statistical bureau has seen fit to throw them together in an unnamed item, while in the case of Japan all these have been itemized.

Though one-sided, the commerce of the United States with Japan and China is yet extensive and important. If the war should become extensive and prolonged this vast commercial interest undoubtedly will be disturbed in no small degree. Should the belligerent powers see fit to blockade the ports of each other the supply of certain commodities will be cut off for the time being. Opinions are divided as to the possibilities of European interference in case of blockade of treaty ports. I am inclined to think that both Japan and China have their own independent rights and responsibilities to do what they like in times of war, and it is only right for other powers to observe strict

neutrality. But if outsiders should want to carry on their trade with either of the belligerents, when the other intends to blockade the ports, it would simply mean aiding and abetting warfare, and therefore they would be considered as violating the terms of neutrality. Reserving this right to herself, the Japanese government has signified her intention of not blockading certain ports in China until the necessity arises. On the other hand, China has not the requisite naval strength to send out boats to blockade Japanese ports. Therefore, for the present at least, there is little apprehension to be felt as to a blockade of the treaty ports of either country.

There are other causes which should be taken into consideration, however. In times of war, men belonging to the industrial classes may be recruited into active service, while others will be required to work on munitions, ammunition, and other military and naval stores rather than in their vocations of peaceful industry. The general public will feel greatly interested and concerned and naturally their attention will be called away from business to matters of war. Such will be the case with the Japanese, I am positively certain. The Japanese people, as a class, are most loyal and patriotic, and when the honor and dignity of the country are at stake they must know the news of the day before anything else. Every minute taken away from the working time of each of those silk-reeling girls, silk-weaving hands, and tea-picking girls must tell in the end upon the production.

Now the American exports to Japan and China, as already shown, are comparatively small, but this might be interfered with by the war, as well as our import trade from those countries. Nations at war cannot afford expenditures for anything but necessaries, and these necessaries in times of war are arms and ammunition. These latter are what are called contrabands of war and therefore liable to seizure by the belligerent governments. All the mail-steamers plying between the Pacific coast of America and Chinese ports have to call at Yokohama on their way to China, and each of them will be subjected there to close inspection by the Japanese government. Therefore, exports from this country to China will be much more seriously disturbed than those to Japan, as China cannot intercept incoming steamers to Yokohama.

The silver element in the commerce of this country with China and Japan is one that must not be lost sight of. Conflicting opinions prevail as to the effect of the present war upon the price of silver. Some say that it will go lower, because the two hostile countries will have to pay in silver for what they buy instead of with commodities, as in times of peace, and that the London market, therefore, will be over-supplied with silver, with the result of causing its price to fall still lower. I am inclined to think that the reverse will be the case. The

combatant nations will need silver more than they require goods, and they need more money than their available supply, and therefore they will draw silver from London by one means or another, and thus the London supply of silver will be decreased and the price, in consequence, increased. Thus far no effect has been shown upon the white metal, the price of which has of late been remarkably steady.

The most annoying effect of the war upon the commercial world up to date is the delay in the transmission of cable messages between America and the east. It is frequently the case with such commodities as silk and tea that offers are kept open only for a short time—say three or four days—and no doubt several important transactions have already fallen through on account of the delays of cablegrams.

The present emergency affords additional proof that a Pacific cable line between San Francisco and Japan, via Honolulu, would be of the greatest importance to the commercial, political, and naval interests of the United States. The war telegrams now coming from various cities in Japan and China not only are delayed in transmission, but the news is far less complete than should be the case during the progress of a great war in these days of electric cables. One cause of the present unsatisfactory news service is due without doubt to the prohibition by the Chinese government of all private messages over their lines; besides, the Siberian land-lines are often liable to interruptions. But with a direct Pacific cable we ought to be in possession of all the news within a few hours of occurrence, and that in an accurate form. While not an expert in telegraphic matters, I cannot help thinking that the ever-increasing commercial and political interests in common of the United States, Hawaiian republic, Japan, China, and other Asiatic countries would be sufficiently important to support a direct cable service. When the present war is over, the commercial importance of the east to the United States will be vastly augmented.

The direct cause of the present war was the rebellion in Corea of a certain faction of malcontents. The rebels proving too much for the government of the peninsular kingdom, the king asked for aid from China, whose government forthwith landed a large force of troops in Corea. Thereupon Japan was compelled to send her troops to the peninsula for the purpose of protecting the lives and property of the Japanese subjects domiciled there. According to a treaty between Japan and China, each country, upon giving due notice to the other, has the right to land troops in Corea. The Japanese have large commercial interests in Corea,—larger, in fact, than all other treaty powers combined.

It must be understood that there have been many disturbances in Corea and in every instance the aim and purpose of the mobs have

been against foreign intercourse. At times the rioters have attacked the Christian missionaries, and, again, the mobs have aimed their blows at the Japanese, including the legation of that country in Seoul. During the last twenty-five years Japan has had a series of provocations sufficiently strong for bombarding Seoul, taking the king prisoner, and making the whole peninsula a Japanese territory.

The great civil war in Japan seventeen years ago was waged over the principle of Corean invasion, and it cost a great deal more than a Corean invasion would have cost. Some of the ablest and most patriotic Japanese generals and statesmen were killed, in addition to an enormous waste of money. But, from a love of peace and civilization, Japan has always shown leniency towards Corea, and the larger part of the originally small indemnities levied against Corea remains unpaid.

On the other hand, it seems certain that China is constantly aiding and abetting the barbarities of the Coreans towards Japanese and other foreign residents. In the recent case of the murder in Shanghai of Kim ok Kun there was very wide room for suspicion of Chinese being behind the screen. Kim ok Kun, a native of Corea, had been a political refugee for years in Japan, protected by the Japanese government. Kim ok Kun was induced by a Corean to go to China for the purpose of interviewing Li Hung Chang, and on his arrival in Shanghai he was stabbed by the supposed friend and then the corpse was placed on board a Chinese man-of-war and sent to Corea, where it was dismembered and exposed to public view in various parts of the country. It may be added that the assassin was discovered to be armed with the authority from the king himself, and on his return home he was promoted to high official rank for his criminal act.

China has been asserting suzerainty over Corea, in spite of the independence of the latter recognized by several civilized nations, including the United States. These countries have treaties of amity and commerce with the kingdom of Corea, and diplomatic representatives are exchanged, as between entirely independent countries. In the present instance, notwithstanding the treaty stipulations, China peremptorily and impudently requested Japan to withdraw her troops from Corea. Japan politely declined, but instead submitted to China propositions to coöperate in introducing reforms in the administration of the Corean government so as to prevent a recurrence of internal commotions which endangered the lives and property of alien residents in the peninsula, including Japanese as well as Chinese. China refused to listen and immediately began warlike preparations. On July 23, at the instigation of the Chinese resident minister at the Corean capital, a combined army of Coreans and Chinese attacked the Japanese garrison at Seoul and were badly defeated, the Japanese taking the king

captive. After several engagements the emperor of Japan on August 1 made a formal declaration of war against China, and the diplomatic representatives were withdrawn from their respective courts. The next day the Chinese emperor issued a characteristic reply. While the fighting is going on between Japan and China the Corean king has accepted the Japanese propositions and authorized his father, Dai In Kun, to proceed with reforms in the administration, with the assistance of the Japanese minister in Seoul.

In fighting strength, on both land and sea, the belligerent countries are not well matched. Homogeneous, united, and patriotic, the Japanese army, drilled to perfection under the best European methods and with weapons of the latest inventions, must, as a matter of course, win victory after victory over the dissimilar, disorganized, timid crowd of Chinese troops, some of whom are said to carry old-fashioned bows and arrows. It must be admitted that China can reënforce her army to ten times as great a number as her combatant; but if numerical strength is the only element required for success in war, all Europe combined would be unable to defeat the Chinese. Japan can, if necessary, send out 150,000 troops, reserving a sufficiently strong force at home to protect herself, and she has enough stores to sustain three years of foreign war.

China has a navy of some forty-seven vessels, whose tonnage is 67,147 tons, as against Japan's thirty-five vessels of 65,526 tons. Many of the Chinese vessels are small unserviceable boats, while some of Japan's are among the most formidable war-ships afloat. China has already lost eight of her best vessels and her northern squadron is now of very little service. Under these circumstances it seems only right that Japan should win in a series of short, sharp, and decisive victories, and bring the Chinese to reason on a proposition for settling differences peacefully. However, the latter are characteristically obstinate and stubborn and the war may drag on indefinitely.

But sooner or later the war must come to an end, when China will find out what modern art and science can do in warfare. The defeat will open the eyes of the Chinese and will lead them to the path of progress, and the result will be a propagation of modern civilization into a land which has never yet been able to avail itself of the advantages of it. We in America shall then see a vast increase of trade and commerce with China and other Asiatic countries.

NIKOLA TESLA AND HIS WORK.*

By Nelson W. Perry, E. M.

IT is not often that it is in good taste to estimate the character of a man while he is living, or safe to weigh his works or to estimate their proper place in any science while it is still in an embryotic state. There are exceptions, however, as in the case of political and other celebrities who, by reason of their eminence, have become in a sense public characters, or whose work has already revolutionized the science in the interest of which it has been undertaken. Under both of these exceptions it seems altogether proper to speak of Mr. Nikola Tesla, for if a man by taking two continents by storm may be called a public character in the sense in which the expression is here used, Mr. Tesla is one, and if the discovery of a new system such as the rotary magnetic field which in a few years has largely revolutionized our methods of conversion of electrical into mechanical energy, and which has formed the basis of the greatest attempt at power-transmission ever made, partakes of the nature of a revolution of the science, then for this reason may Mr. Tesla's work be reviewed with propriety while their author is still in the flesh.

Mr. Tesla was born in 1857, and therefore is still quite a young man, but he has crowded within his thirty-seven years of life an experience that would be considered ripe for any one of a dozen other men if it were divided equally among them. While foreign-born (at Smiljan-Lika on the borderland of Austro-Hungary), he is an American by adoption. Though proud of his adopted country he is not so intensely American as some foreigners become who adopt this country as their home.

The one discovery of Mr. Tesla which among practical men stands out most prominently to-day, because of the practical results already obtained, is his discovery of what is generally known as the rotating magnetic field. The alternating current, as the name would imply, means a current which changes its direction periodically. It possesses many characteristics peculiar to itself. The distinct advantage of an alternat-

* In the publisher's announcement, some months ago, of a series of papers on "Electrical Science up to Date," was included the promise of a paper in this volume of THE ENGINEERING MAGAZINE, by Mr. Nikola Tesla, on "Electric-Lighting Without Heat." Only the unfortunate condition of the health of Mr. Tesla has postponed his compliance with his engagement in this connection. In order to keep faith, so far as possible, with the readers of the Magazine, there is presented herewith a paper by an electrical engineer who enjoys the acquaintance of Mr. Tesla, reviewing the discoveries of the latter gentleman which it was hoped that the inventor himself would be able to describe for us. The paper thus prepared has received the approval of Mr. Tesla, who, indeed, furnished personally some of the suggestions upon which it is based.—THE EDITOR.

ing or undulating current over a steady current such as heretofore used in arc-lighting is, that one is able to dispense with a large resistance in the dynamos and lamps which are necessary in order to obtain a steady light. This produces a greater economy in the circuit all along. For transmission purposes its advantages so far outweigh its disadvantages as to make it the method *par excellence*. Alternating-current motors enable us to obtain results which are not possible with motors heretofore used, namely: the motor may be made to run in perfect synchronism with the generators. In the ordinary motors the speed as is known falls below this increase, but not so in the motors just mentioned. But if one desires it is possible also to exactly imitate an ordinary direct-current motor and produce a machine which will have a great effort on the start.

Mr. Tesla conceived an idea which has entirely overcome the shortcomings of the alternating current as applied to motors. Every one knows—or at least is easy of demonstration—that if the north and south poles of a small horseshoe magnet be suspended over a bar of soft iron free to revolve in a horizontal plane, or be placed over an ordinary compass-needle, the latter will be attracted at either end by the poles of the magnet and take up a position parallel to a straight line drawn between the two poles of the magnet. Now if the latter be revolved through any angle the soft iron or needle will follow, being dragged around by the magnet, and if the magnet be caused to revolve regularly the iron will also revolve, being pulled around by the full force of the magnet. It was not feasible, however, to cause the magnet to revolve in this way, and Tesla's invention consisted in obviating this trouble and, in fact, in greatly simplifying the problem. He conceived the idea that if he took an iron ring and used two alternating currents, one of which had its maximum value at the instant that the other had a zero value—or, in other words, two currents whose periods were such that one waned as the other increased—he could produce in that iron ring by winding these circuits in alternate coils surfaces that without any mechanical movement of the parts would travel around that ring with a rapidity equal to the number of changes of direction of the currents employed. He thus had a ring, the north and south poles of which were rapidly revolving just as would the poles of the horseshoe magnet were it tied at its middle to a twisted string and allowed to revolve. A piece of iron pivoted at its middle placed concentric with this ring would therefore be dragged around by the changing poles of the ring. He had thus discovered what is somewhat awkwardly expressed by the expression, "the rotary magnetic field," and also the use of what have been termed "polyphased currents"—the one referring to the magnetism and the other

to the combination of currents by which this changing magnetism was produced. This discovery is undoubtedly one of the most important that has ever been made within the domain of alternating currents, and marks a most important step in applied electricity; in fact, it may be said to have been epoch-making, for without this method the experiment of transmitting 100 horse-power, 108 miles from Lauffen on the falls of the Neckar to the Frankfort Exposition grounds, in 1891, would have been impracticable.

If two separate currents are employed as Tesla employs them, we have what is called a "diphased" system; if three are employed it is called a "triphased" system; but in speaking of the employment of more than one current the generic term "polyphased" is used. Tesla's discovery is the basis of them all. The Frankfort-Lauffen experiment referred to was operated on the three-phased system. The great scheme of transmitting Niagara's power to distant points, which in magnitude far surpasses the former experiment, will employ the original Tesla diphased system.

His first successful experiment was in 1883, but the first practical motor that showed good efficiency was only obtained in 1887. Ferraris published a pamphlet bearing on the broad principles and some features of the discovery in May, 1888, but six months prior to this, that is in October, 1887, Tesla's first fundamental applications were filed in the Patent Office in Washington.

There is no conflict between Ferraris and Tesla, each according to the other full honor and credit for the work individually done.

As before stated, the discovery of the rotary field has nearly revolutionized the practice of tranmission of energy by alternating currents and the practical value of the invention is fully attested by the adoption by the most eminent experts in the world of the Tesla system for the Niagara electrical plant, by which it is proposed to transmit eventually at least 100,000 horse-power from the falls to various points along the Erie canal, as far as such transmission may prove economical. This invention at once attracted the eyes of the scientific world to Mr. Tesla, who was until then comparatively unknown. He has, however, been an indefatigable worker and has made many inventions which have attracted little attention, often only because of their lesser importance. Mr. T. Commerford Martin, in his exhaustive work on the "Inventions, Researches, and Writings of Nikola Tesla," catalogues 137 inventions or discoveries made by this man. There is not room here for even this catalogue and in discussing his work it will be necessary for me to confine myself strictly to a few of his accomplishments upon which his fame chiefly depends.

Mr. Tesla early turned his attention to phenomena of alternating

currents of high frequency and high potential. These brilliant effects which have so much interested scientific men are obtained in his experiments by a peculiar arrangement of condensers and coils, which enables him to obtain enormous potentials of a million volts or more which are alternated in direction many million times a second, if necessary. In the reports of his lectures his apparatus is minutely described, but limited space does not permit me to dwell upon it here. Others had experimented with currents of several thousand volts and as many reversals or more per minute. The phenomena thereby produced were so interesting as to lead Mr. Tesla to explore the field further. He employed currents of hundreds of thousands of volts and having more than 2,000,000 reversals per minute. With these elements at hand he possessed the key with which he unlocked entirely unexplored avenues and produced effects, especially of light, that literally dazzled the scientific world.

Maxwell had taught the world to believe that ordinary light was due to electromagnetic waves of the ether, having a frequency per second of 5 with 14 ciphers after it. He did not prove this, but arrived at his conclusions through mathematical logic. Later Heinrich Hertz proved the truth of these deductions experimentally. This meant that if, by any possible means, we could artificially produce ether waves of this frequency, we would have light without heat and a useful efficiency for the energy expended of about 99 per cent. instead of an efficiency of less than 1 per cent. as obtained in our best gas-burners. We can readily produce etheric waves of a frequency of some hundreds of thousands and even millions, but these fall far short of the requirements in the case, and there were practical obstacles in the way preventing the slightest hope of our ever being able to produce the required frequency or to transmit them if we could produce them. It was Tesla's idea that the desired results were possible of attainment by means of powerful electro-static effects which, by the way, he was able to produce by his peculiar methods and apparatus invented for this purpose and high potentials.

Of course the general bearing of these experiments is upon the problem of an efficient production of light, but in his lectures many scientific facts are pointed out, which contributed to a radical change in scientific opinion in regard to a number of phenomena. So for instance it was demonstrated that a gaseous medium like air, when electric stress of great intensity and frequency were made to act through it, becomes rigid. The agitation produced by the stress in the molecules of the air is such as to render the air luminous, and he produced in some experiments streams of light by merely charging the body. In fact it appears possible from some experiments that a flame might be produced which would appear to be ordinary gas-flame and yet it

would be a solid. The phenomenon of the aurora borealis and of the electric storms are usually attributed to the changes of the potential of the sun. A very important fact was demonstrated that in an electrical condenser and in any insulating material, the air must be kept away. As long as this fact was not known it was not possible to properly insulate parts of high tension.

I give here a paragraph on this subject in his own words: *

But powerful electro-static effects are a *sine qua non* of light-production on the lines indicated by theory. Electromagnetic effects are primarily unavailable, for the reason that to produce the required effects we would have to pass current impulses through a conductor, which, long before the required frequency of the impulses could be reached, would cease to transmit them. On the other hand, electromagnetic waves many times longer than those of light, and producible by sudden discharge of a condenser, could not be utilized.....We could not affect by means of such waves the static molecular or atomic charges of a gas, cause them to vibrate and emit light.

To produce such luminous effects, straight electro-static thrusts are required; these, whatever be their frequency, may disturb the molecular charges and produce light.

It is to be regretted that lack of space here prevents the elucidation of the terms used, but the fact will be well understood without this, that the production of light practically without heat is within the bounds of possibility. This was Tesla's grand discovery and it was this that dazzled the mental vision of the scientific world. It only remained for him to illustrate his theory by experiments that the physical vision of the world should also be dazzled. He further says:

It has occurred to me, however, that electro-static effects are in many ways available for the production of light. For instance, we may place a body of some refractory material in a closed, and preferably more or less exhausted globe, connect it to a source of high, rapidly-alternating potential, causing the molecules of the gas to strike it many times a second at enormous speeds, and in this manner, with trillions of invisible hammers, pound it until it gets incandescent; or we may place a body in a very highly exhausted globe, in a non-striking vacuum, and by employing very high frequencies and potentials, transfer sufficient energy from it to other bodies in the vicinity, or in general to the surroundings, to maintain it at any degree of incandescence, or we may, by means of such rapidly alternating high potentials, disturb the ether carried by the molecules of a gas or their static charges, causing them to vibrate and to emit light.

Here are clearly enunciated three distinct methods of producing light by electro-static action, any one of which would have startled the scientific world if founded solely on hypothesis. Tesla's announcement was based on no such unstable basis as this, however; it was based on experimental data which he reproduced before his audiences. Some of these effects had in fact been produced in a feeble way by previous investigators in a somewhat different manner, but it remained for Tesla to bring them out in a far more brilliant way than any of his predecessors and thereby to call attention to their importance that they had not previously attracted. In regard to this, he says:

* Tesla's lecture before the American Institute of Electrical Engineers, delivered at the School of Mines, Columbia College, May 20, 1891.

But electro-static effects being dependent upon the potential *and* frequency, to produce the most powerful action it is desirable to increase both as far as practicable. [Tesla was the first to realize and practise this.] It may be possible to obtain quite fair results by keeping either of these factors small provided the other is sufficiently great; but we are limited in both directions. My experience demonstrates that we cannot go below a certain frequency, for, first the potential then becomes so great that it is dangerous; and secondly, the light production is less efficient.

Speaking of what has been termed the bombardment method (the first of the three above mentioned), he says:

There is no difficulty in reaching such high degrees of incandescence *that ordinary carbon is to all appearance melted and volatilized.* If the vacuum could be made absolutely perfect, such a lamp, although inoperative with apparatus ordinarily used, would, if operated with currents of the required character, afford an illuminant which would never be destroyed, and which would be far more efficient than an ordinary incandescent lamp.

In lamps constructed on this principle, the filament or button of refractory material was connected to but one terminal of the circuit instead of to both as necessary in present practice.

In regard to the second method, Mr. Tesla says:

The use of alternating currents of very high frequency makes it possible to transfer, by electro-static or electromagnetic induction through the glass of the lamp, sufficient energy to keep a filament at incandescence and *so do* away with the leading in wires. Many forms of lamps on this principle with continuous and broken filaments have been constructed by me and experimented upon.

Thus far he had used in the first case a single connection to the source of energy and in the second no connection at all, but in both cases some refractory material within the globe was brought to incandescence and served as the light-giving body. In the third method, however, he used neither connections nor filaments or buttons, but merely exhausted tubes having no electrodes whatever. Such tubes when grasped in the hands of the experimenter standing near an induction coil became luminous themselves. This seems to be a most remarkable phenomenon, as there is nothing from which the light can emanate. It would seem that the tubes were filled with a luminous substance which was light itself. Speaking of this phenomenon he says:

In all cases, then, when we excite luminosity in exhausted tubes by means of such a coil, the effect is due to the rapidly alternating electro-static potential and furthermore it must be attributed to the harmonic alternation produced by the machine and not to any superposed vibration which might be thought to exist. . . . . In all the last-described experiments, tubes devoid of any electrodes may be used and there is no difficulty in producing by their means sufficient light to read by. The light effect is, however, considerably increased by the use of phosphorescent bodies such as yttria, uranium glass, etc.

But he caps the climax of this brilliant series of experiments by producing conditions whereby a vacuum tube without electrodes may be moved anywhere within the room and, with no connection whatever to the walls, still remain luminous. He says:

For this purpose I suspend a sheet of metal a distance from the ceiling on insulating cords and connect it to one terminal of the induction coil, the other terminal being preferably connected with the ground; or else I suspend two sheets, each being connected to one terminal of the coil, and their size being carefully determined. An exhausted tube may then be carried in the hand anywhere between the sheets or placed anywhere, even a certain distance beyond them; it remains always luminous.

During this lecture Mr. Tesla performed all of the experiments referred to and many more before his audience and then, summing up his own belief as to their value, he said:

How far the results here borne out are capable of practical applications will be decided in the future. As regards the production of light, some results already reached are encouraging and make me confident in asserting that the practical solution of the problem lies in the direction I have endeavored to indicate. Still, whatever may be the immediate outcome of these experiments I am hopeful that they will only prove a step in further development towards the ideal and final perfection. The possibilities which are opened by modern research are so vast that even the most reserved must feel sanguine of the future. Eminent scientists consider the problem of utilizing one kind of radiation without the others a rational one. In an apparatus designed for the production of light by conversion from any form of energy into that of light, such a result can never be reached, for no matter what the process of producing the required vibrations, be it electrical, chemical, or any other, it will not be possible to obtain the higher light vibrations without going through the lower heat vibrations. It is the problem of imparting to a body a certain velocity without passing through all lower velocities. But there is a possibility of obtaining energy not only in the form of light, but motive power, and energy of any other form, in some more direct way from the medium. The time will be when this will be accomplished, and the time has come when one may utter such words before an enlightened audience without being considered a visionary. We are whirling through endless space with an inconceivable speed; all around us everything is spinning, everything is moving, everywhere is energy. There *must* be some way of availing ourselves of this energy more directly. Then, with the light obtained from the medium, with the power derived from it, with every form of energy obtained without effort, from the store forever inexhaustible, humanity will advance with giant strides. The mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes, and fills our hearts with supreme delight.

While none of these experiments on light have developed into practical processes, they constitute one of the most remarkable contributions to physical science since the days of Faraday. In the brilliancy of their conception and the beauty of the results obtained we are apt to lose sight of the great inventive genius that was required to devise and prepare apparatus suitable for their public production. Nowhere has the genius of Tesla been displayed to better advantage than in the production of suitable means to the desired ends, and the last public announcement he has made was a description of a mechanical and electrical oscillator by which his investigations of alternating currents would be facilitated.

His lecture of May 20, 1891, echoed around the world and attracted the attention of the gray-haired savants of Europe. He was at once besieged by invitations to repeat his lecture abroad and, on

February 3, 1892, he delivered his lecture with some additions before the most learned men of England, and received at their hands an ovation such as has perhaps never before been accorded to a scientific man. The last public appearance of Mr. Tesla was in a lecture during the Electrical Congress at the World's Fair, which was attended by the principal savants of Europe and America.

But Mr. Tesla is having the experience of all pioneers whose work does not show immediate practical results. One of the leading savants of Europe said to me after Tesla's last lecture: "His work is brilliant, but of what use is it? I would rather see him devote his energies to something more practical."

At this lecture Mr. Tesla exhibited and described a mechanical oscillator in which he had great confidence. He believed that its future possibilities in a practical way were great. He is still of that opinion and, notwithstanding the criticism just quoted, Mr. Tesla says that this invention contains the germ of the most practical work he has ever done. He probably knows best about this and we shall await the outcome with great interest. We are not at liberty to speak freely concerning this invention at this time, but when Mr. Tesla is ready to make an announcement we may hear something startling.

I believe that this sentiment finds considerable response among the scientists abroad. Faraday was constantly met with the question, *cui bono?* and Tesla cannot hope to escape the same experience. Faraday's minute electric spark obtained by electromagnetic induction was his baby. The question was reiterated, *cui bono?* That baby has now grown to man's estate and appears in the form of the 5000 horse-power Tesla generators now nearly completed for the great Niagara Falls transmission plant. The experiments in light, a few of which I have briefly referred to, are Tesla's babies. Who knows how they may appear in mature development?

My own estimate of Tesla is that his is one of the most vigorous and original minds the world has ever produced. Whether he will ever rank with Faraday, whom he resembles in many ways, I do not know, but there is no one in history whose work and character so closely resembles Faraday's to my mind as Tesla's. But Tesla's work is not finished. He is now engaged on something which he tells me he regards as the best work that he has ever done. What it may be the near future will disclose. It is unfair to write one's eulogium until his work is done. Tesla's work, perhaps, has only commenced.

LESSONS OF THE RICHMOND ELECTRIC RAILWAY.

By Frank J. Sprague.

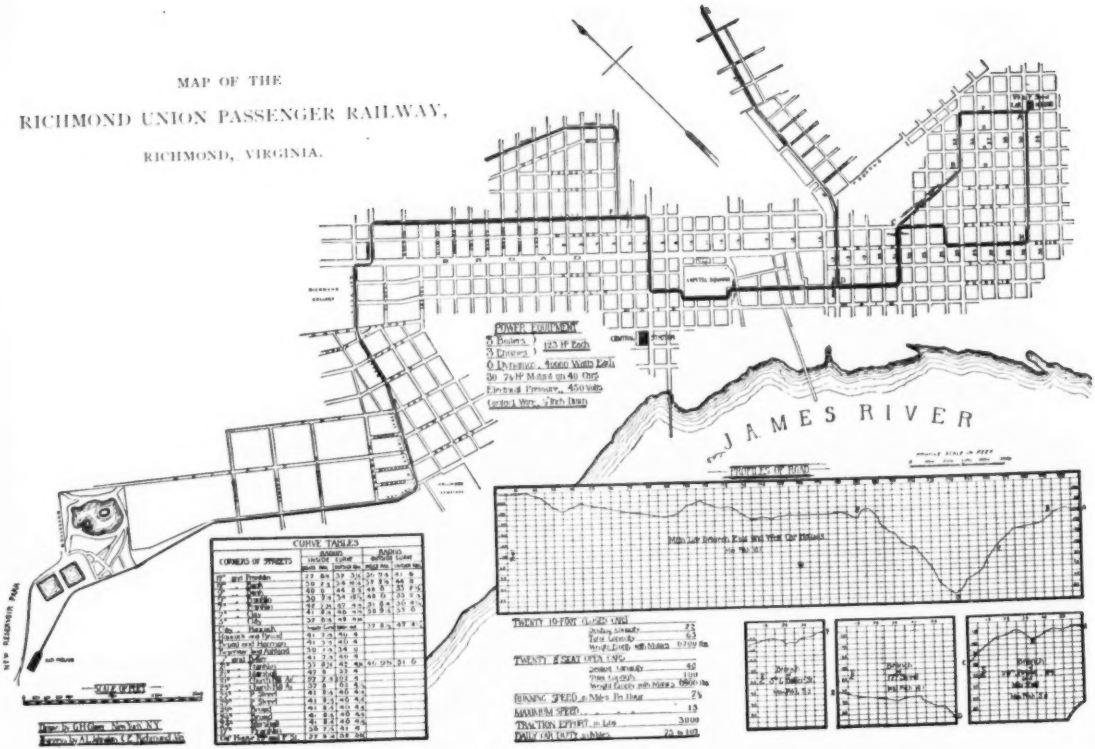
THE year 1887 marked an epoch in one of the most important of modern industrial revolutions, and curiously enough a city in the southern United States was the place selected, largely by chance, for northern capital and enterprise to carry out a grave experiment. Scarcely seven years ago those enthusiastic pioneers who,—poor in pocket and struggling against unbelief and ridicule, yet confident in the ultimate outcome of their endeavors,—proclaimed the future success of electric railways, surely had little enough in the way of practical results on which to base their prophecies. There were altogether perhaps a dozen electric railways of various types in existence; none was so satisfactory as to warrant general adoption, and all were handicapped by their special experimental character. Capitalists, car-builders, railway officials, engineers, offered no encouragement; electricians themselves were in the main doubtful. The electric motor was limited in its applications. It was looked upon as a piece of complicated machinery to be carefully housed and suspiciously watched. It was hydrophobic in character, eccentric in operation. Its construction was crude, its design unsatisfactory, its functions more or less mysterious. The vagaries of the electric current were many, its evasiveness surprising.

When it was proposed to use this agent to overturn the existing tramway systems of the United States,—to put a motor under a car, exposed to dust, moisture, and all the evils of negligent treatment,—there were thought to be good grounds for insanity. To connect it to the wheel by gearing was to violate the laws of mechanics. To govern two or more such machines out of sight was "playing" a lottery. To tempt a wayward current of comparatively high pressure by using the ground as a return was enough to disturb the ghost of Ben Franklin. The ordinary conditions of a street-car service were pronounced an insuperable obstacle to any self-propelled car; a greater than 6-per-cent. grade was declared to be prohibitory. The investment of copper for a multiple-arc system of supply was financially forbidden. Four hundred and fifty volts potential threatened unknown terrors of torture and death, and a bare overhead wire promised innumerable holocausts. Even nature, with its mud, snow, and ice, was to rise in rebellion.

MAP OF THE

RICHMOND UNION PASSENGER RAILWAY,

RICHMOND, VIRGINIA.



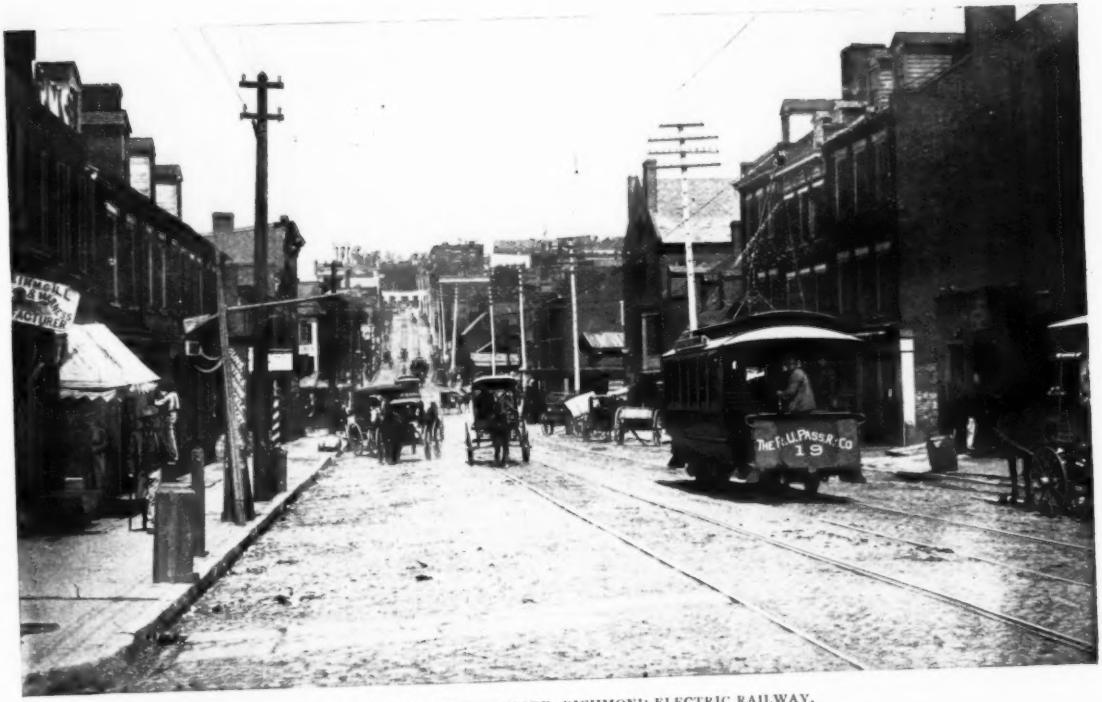
CURVE TABLES

CORNERS OF STREETS	RADIUS INSIDE CURVE		RADIUS OUTSIDE CURVE	
	Starts No.	Central An.	Ends No.	Length No.
1st and Franklin	27	84	39	34
2d "	30	73	54	40
3d "	40	6	44	5
4th "	30	73	54	40
5th "	27	42	42	31
6th "	27	42	42	31
7th "	37	85	48	44
8th "				
Broad and Franklin	41	73	41	6
Grace and Franklin	41	73	41	6
Grace and Harrison	41	73	41	6
Grace and Jackson	50	73	54	5
Grace and Belvidere	51	73	54	5
Broad and Harrison	41	82	45	44
Broad and Jackson	42	82	45	44
Broad and Belvidere	42	82	45	44
Broad and Mc Adoo	22	82	45	44
Broad and Mc Adoo	22	82	45	44
Broad and Lombardy	41	82	45	44
Broad and Meadow	41	82	45	44
Broad and Hermitage	41	82	45	44
Broad and Laburnum	41	82	45	44
Broad and Virginia	41	82	45	44
Broad and Hill	41	82	45	44
Broad and Mc Adoo	41	82	45	44
Broad and Belvidere	42	82	45	44
Broad and Lombardy	42	82	45	44
Broad and Meadow	42	82	45	44
Broad and Hermitage	42	82	45	44
Broad and Laburnum	42	82	45	44
Broad and Virginia	42	82	45	44
Broad and Hill	42	82	45	44
Broad and Mc Adoo	42

Such was the condition of affairs when, in the spring of 1887, a contract was made between the capitalists representing the Union City railway of Richmond, Virginia, and the Sprague Electric Railway and Motor Company, of New York city. This contract was unique. It called for the completion in ninety days of the equipment of a road at that time unlaid and with a route determined only in part. It provided for a complete steam and electric plant of 375 horse-power capacity, the furnishing of forty cars with eighty motors and all appurtenances necessary for their operation, and a complete overhead system. Thirty of the cars were to be operated at one time, and grades as high as 8 per cent. to be ascended. The price for the equipment was $110,000, to be paid in cash after sixty days "satisfactory" operation.

At the time of taking the contract, the Sprague company had only a blue-print of a railroad machine and some experimental motors used on the elevated road. The hundred-and-one details essential to success were undetermined. Such a contract is one which no business man would ordinarily assume, especially in view of the entirely unprepared state of the company. It was justified by subsequent events because of the pioneer character of the work. Considering all the difficulties which confronted the company, it is probable that, had they been known beforehand and the solution of them unforeseen this contract would never have been made. Fortunately for the future of electric railways the difficulties could not all be foretold and did not have to be met simultaneously. The road cost before completion not less than $160,000, and only $45,000 was paid in cash, with a like amount in bonds. Enormous as this expense was, as grave the risks, the results have entirely justified them all, for the Richmond road stands as the prototype in almost every essential detail of the modern electric trolley system. There was met every difficulty which could be encountered in an overhead system on heavy grades and with sharp curves, and there was settled for all time the question of the economical operation of a large system of street-railways by methods of direct supply.

The limits of this article prohibit more than a reference to the essential features of the new system, the special characteristics of the road, and some personal reminiscences of its development. Briefly speaking, the equipment was what is known as a single overhead trolley system with ground return. The current was distributed by feeders to certain central points from which it was taken by a main conductor extending the entire length of the road, it feeding in turn at intervals of about a thousand feet a working conductor of constant size, one-fifth of an inch in diameter, of hard-drawn silicon wire,



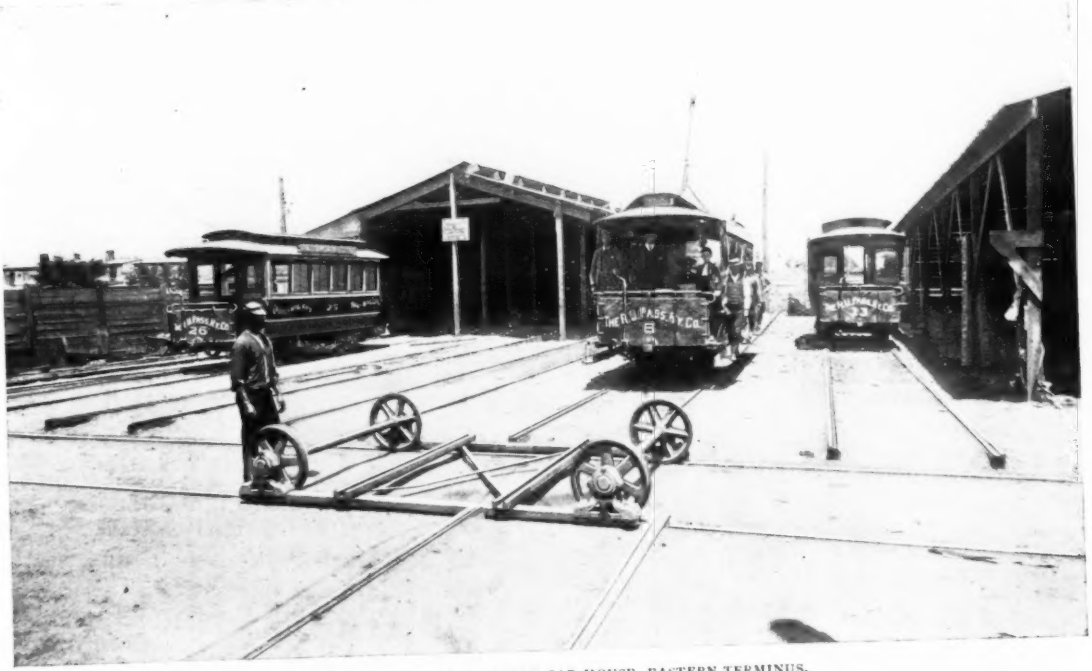
THE FRANKLIN-STREET GRADE, RICHMOND ELECTRIC RAILWAY.

known technically as the "trolley" wire. From this the current was taken by an under-running trolley with upper-pressure contact carried in the middle of the car and having a universally flexible movement. Thence it was carried to the controlling switches on each platform, arranged to control the motors in series or multiple and to make the necessary changes in the field circuits.

The motors, of which there were two, were each centered on a driving axle, directly geared to it with single reduction, and flexibly supported at the free end, so as to allow perfect freedom of movement of the machine while maintaining parallelism between the axes of the car axle and the motor-shaft. Fixed brushes were used on the commutators for forward and back motion. The current, after passing through the motors, went by way of the wheels into the track and thence, partly by the track, the rails of which were connected together and likewise reënforced by a continuous wire, and partly by the earth and the water-pipes and gas-pipes to which the rail system was connected at various points by earth-plates sunk in deep wells, back to the central station. The main features are those which are common to every trolley system of to-day. Some of them, more particularly those relating to motor mounting, had been shown in 1886 in an experimental equipment on the Thirty-Fourth street branch of the elevated railroad in New York city, on some individual cars used for storage-battery tests in New York, Philadelphia, and Boston, and on the initial equipment of the Union passenger railway of St. Joseph, Missouri, which contract slightly preceded that of Richmond, but generally they saw their first application on a commercial scale in the latter city.

A brief inspection of the map of this road and the curve and grade characteristics will give some idea of the difficulties to be overcome, but these formed only a part, and it is fortunate that in the development of this road the writer had the assistance of two young officers, Lieutenant Crosby, a graduate of West Point, and Ensign S. Dana Greene, of Annapolis (which was my own alma mater), who, though entirely inexperienced in electric street-railway work, had energy, pluck, and endurance. It needed all the advantages of youth and enthusiasm, as well as a high technical training, to carry the work through to a successful end. Their work was largely supplemented by that of a number of men who, though not trained engineers, and under adverse conditions and with many hardships, faithfully worked for victory.

Our contract was made in May, and in July I was laid up with an attack of typhoid fever which, with my period of convalescence, kept me away for nine weeks, leaving almost the entire burden on those



RICHMOND ELECTRIC RAILWAY CAR-HOUSE, EASTERN TERMINUS.

who were associated with me. Returning to duty about October 1, I hastened to Richmond to go over the route and note the condition of the work. Up to that time I had never seen the road. Much of the track-work had been finished, poles had been set, some of the machines constructed, the central station was well under way, and considerable experimental work was in hand. The owners of the road were clamorous to begin operations, while the excuses on our part were without number. I shall never forget the feeling I had when, returning from the improvised car-shed, I stopped at the foot of Franklin-street hill. As I looked up this incline under the bridge connecting the Ballard and Exchange hotels, and saw a grade varying from 4 to 10 per cent. rising above the bridge, I was for a moment doubtful of the outcome, and I began to realize the difficulties, not only those pertinent to our own work but others forced on us by the unusual and unforeseen conditions under which we had undertaken it.

The track was simply execrable, laid for profit, not for permanence, and with no adequate idea of the necessities. It was a flat 27-pound tram-rail of antiquated shape, poorly jointed, unevenly laid in red clay, and insecurely tied together. The total trackage was about twelve miles; it ran in the most irregular way over about nine miles of streets. Part was double- and part was single-track, a part laid on paved streets, but the larger balance on macadam, or unpaved streets. There were twenty-nine curves, five being of less than 30 feet radius. On these sharp curves were grades as high as 8 per cent.; there were straight grades as high as 10 per cent. The outer rails were often inches below the inner ones, and the whole track at times would disappear into the red clay which froze over it and stuck with remarkable tenacity. As I have said, the sight of the main grade was one of my most unpleasant sensations. There were two things which seemed probable. The first was that the car, for lack of track adhesion, would not ascend the grade at all no matter how powerful the machines, and the second was that I knew the latter were lacking in capacity.

Our first machines had been built with one reduction of gearing, to which all street-railway practice is now gravitating. An 8-per-cent. grade would strain them, and a 10-per-cent. grade was probably fatal. Hastening back to New York we held a consultation as to what should be done. The easiest way out of the difficulty seemed to be to run on heavy grades with a cable operated by electric motors in pits sunk beneath the track—a feasible plan if the car could not by its own adhesion mount a 10-per.cent. grade; on the other hand, if it did have sufficient adhesion, then a change in the machines was necessary. The

most direct thing which suggested itself was the introduction of an intermediate gear, and, as it was constructed, this proved to be a most serious problem.

Before deciding upon this, the laconic advice of the president of the company, Mr. E. H. Johnson, was "to find out whether the car can get up the grade at all" : this advice was sound enough, and I returned to Richmond to try the experiment. The first test was when we stopped in the middle of a sharp curve with the car apparently locked. I told the manager, Mr. George Burt, formerly of the Panama Railway Company, that I would pull the car out of the curve if it wrecked the machines, and, when called upon, they responded nobly. This was a very convincing experiment to him, although not entirely so to me, because it did not settle the question of track-adhesion. Having got out of our temporary difficulty, we made a run to the foot of the Franklin-street hill, our course being distinguished by a free fight in which an eccentric inhabitant, somewhat the worse for liquor and politically excited, nearly cleaned out our party, until one or two of our best fighting men got into trim, after which we proceeded peaceably.

Arriving at the foot of the hill, we stopped to survey the enemy. When I expressed doubt of the ability of the machines to make the ascent, Burt said : "If you can get out of such a curve as that we just left, you can go up the side of a wall." I knew that even if we succeeded the machines would probably be wrecked, but there was nothing to do but to try it, so, putting on the current, we steadily climbed up this hill, then another, and another around several curves, finally reaching the highest point in the heart of the city. By this time the machines were boiling hot, and we stopped in the center of an admiring crowd in the hope that they would cool down so as to allow us to proceed. No sooner had we started than there was a peculiar movement, then strange but afterwards very familiar, due to a crossed armature, and I knew that we were disabled. We ran on for a block in our crippled condition surrounded by a howling mob who seemed bent on taking possession. Not caring to confess serious trouble, I told Greene in a tone so that I was generally heard that there was some slight disarrangement of the circuits, that he had better go and get his instruments ; meanwhile I put out the lights and stretched out in the bottom of the car for a rest. The crowd dispersed and, after a long time, Greene returned with his "instruments,"—four big powerful mules, at that moment the most effective we could get. We soon began our retrograde journey, at first with the mules in the rear, because by cutting out one machine I hoped to get back with the other. Being on the wrong track and with severe grades and

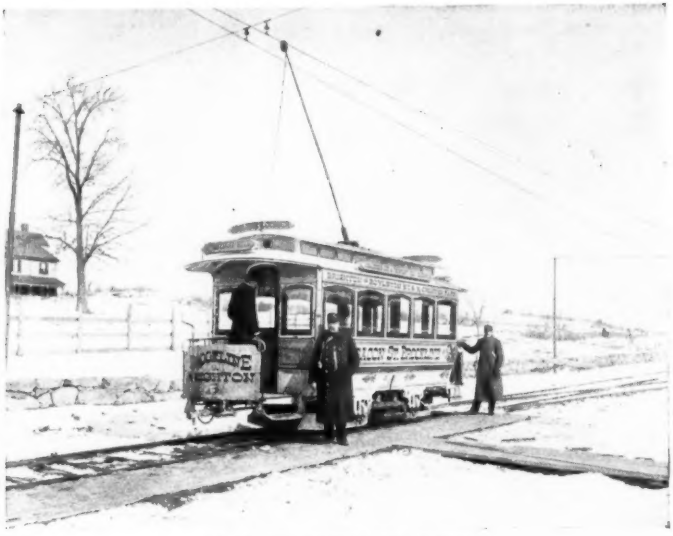
CARS BANKED UP AT EASTERN TERMINUS, RICHMOND ELECTRIC RAILWAY.

curves, I knew it to be a doubtful feat. On approaching one of them on a slight down grade I shouted for every one to jump and give the car a push, put on the full current, and, before I could realize it the car had left the curve and run into the foundation-stones of a hotel. There was no question this time about our being disabled, and we had reluctantly to turn to our mules for assistance. This is but one of many similar night experiences, but, despite our damaged condition, we had settled once for all one problem, and that was that with all the weight of the car used for traction, a 10-per-cent. grade could be ascended: but having settled this, we were face to face with the necessity of introducing an intermediate gear with a distance between the armature shaft and car axle of only 12½ inches on machines entirely unprepared for any such change. Hastening back to New York it occurred to me to put a stud on one end of the machine carrying a gear and a pinion of smaller size, into the former of which the armature pinion should mesh while the latter should engage the teeth of an internally-split gear on the car-axle. It was a happy thought, for the strain on the stud was largely removed because the moments were equal and opposite on one side. Hastening to the Brown and Sharpe Manufacturing Company, in Providence, R. I., I laid my difficulties before them, representing how vital every day's delay was to me, and gave orders that so far as it was possible, night and day, without regard to expense, they should get out a set of tools and jigs which would permit us to alter our machines in Richmond, and at the same time to make the necessary patterns and to cast the requisite gears. Their response was prompt, and in a few weeks we had removed all of our machines, taken them apart, changed them over, introduced the new gears, and they were again ready for running.

Troubles with gear reduction, serious as they were, formed only a small part of our difficulties. Field-magnets, hastily wound in sections with crude insulation, frequently grounded and crossed. The armatures had a commutator on each end, and were so connected as to bring the brushes at each end on top for easy inspection. Our overhead work was most unsatisfactory. No less than from fifty to sixty designs of trolleys of almost every conceivable shape and character had been brought out. The work of mounting the machines and changing them was conducted practically out of doors, subject to all the inclemencies of a wet Richmond winter.

Into the details of all the work I cannot enter here, but by the end of January the time had come when it was vital for us to start. The owners of the road, taking advantage of our difficulties and naturally disappointed and alarmed, threatened to cancel the contract and forced us to grave concessions. Meanwhile every man had been under in-

ELECTRIC CAR JUMPING THE FIRE-HOSE—RICHMOND, VA.



THE BEACON-STREET LINE, BOSTON.

[The first overhead system in the city: the sequel to the visit to Richmond of Mr. Whitney.]

tense strain; day and night work was the rule. Everything made under this pressure cost vastly more than under any other condition. Changes were frequent, decided upon almost instantly because of the necessity of doing something, and hence without careful deliberation. The road must be made to go; it meant financial ruin for many unless it did. To the railway development its failure would prove a most serious blow. My own reputation and future career, as well as that of my associates, seemed blasted if failure marked the Richmond road.

About the end of the month we prepared to open the road with ten cars. At this time matters were going more smoothly, the overhead work had been gotten into fair condition, the central station was all right. The new gearing was apparently a success, many of the difficulties with machines and switches had been overcome. As a preliminary we spent a day carrying the children of the town and on February 8, 1888, in a drizzling rain, we opened the line for regular service. The day was one of disappointment. The cars, crowded with passengers, would one after another suddenly stop in the street and refuse to move, or to be moved, because of locked gears. A man would go under the car, take off one gear, and continue, if possible, with the

other machine, or bodily haul the car off the track so that another could go by. Opinions as to the difficulty were not agreed, but one reliable man, Pat O'Shaughnessy, who has been engaged at work with me for many years, and who is possessed of a most happy mechanical judgment, speedily detected the trouble and was not long in finding the remedy.

Of all the difficulties met, one of the most exasperating was that connected with running with fixed brushes. For a long time it seemed almost as if this would prove a failure. The armatures were continually grounding or crossing, and one of the commutators was particularly badly burned, the mica itself being charred and the copper blistered. After a time we found that this was largely due to the fact that the current always went into one brush and out at the other, and then we adopted the practice of reversing the armature circuits instead of the fields for a change in direction.

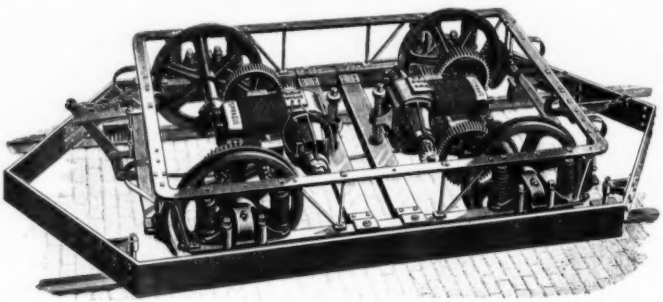
It seemed, however, that we had no copper commutator good enough, and there followed a change of every commutator on the road. Not only special forms of commutators were made, but special materials were made in various places. Before the final adoption of carbon, the variety of brushes tried was without number; sometimes flat ones, solid and laminated, which would wear through, double over and hug

"THE RIVALS."

[Sprague car under 11-foot railway bridge, Steubenville, Ohio.]

an arc of the commutator, or oblique, solid, and laminated brushes which would catch in the bars, reverse or split, and straddle the commutators, with the direct result of ruin to commutators, crossed armatures, and burned-out fields. It was a daily occurrence to see a loaded car climb a grade with a lurid green glare lighting up the track, but with no possibility of getting at it, although I knew that $100 worth of damage would be the result of the trip. Then we tried tilting brushes and variously-shaped pieces of copper, bronze, and brass set on end, and pressed down by all sorts of springs, and finally solid bars of brass set on end.

About this time $9 worth of brass per day, milled off by the rough bars of the commutator, lined the track with a glittering path; not a single trip was made without inspection, with generally a change of brushes or some other repair. But this was not all. Every armature



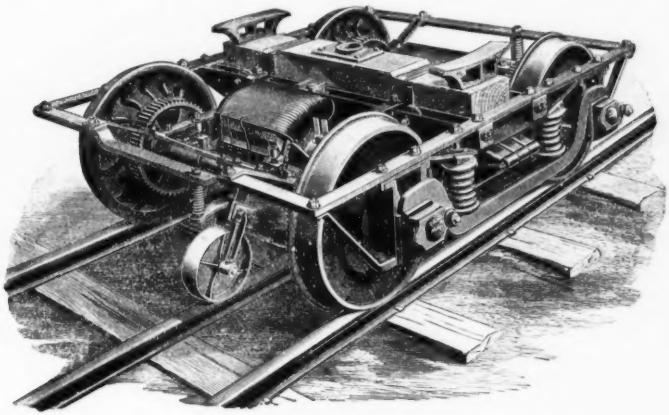
VIEW OF INDEPENDENT TRUCK, EQUIPPED WITH SPRAGUE ELECTRIC MOTORS.

was unwound, the bodies shortened, and then rewound. Disabled armatures were numberless, and to keep the road in operation tons of machinery were shipped by express. Frequent change of parts were necessary, and, since the machines had not been built on the interchangeable principle, in a few weeks they were of the most heterogeneous character.

We managed, however, to keep the cars going, and gradually we saw our difficulties lessening, although new ones would crop up, and little by little the number of cars in operation was increased from ten to twenty, then to thirty, and finally one of our most reliable men, David Mason, put forty cars into operation, or ten more than the station or line equipment called for. In the three months of operation from February until May, 1888, despite innumerable changes and troubles inconceivable, no car in Richmond was pulled a foot by animal power, for if any accident occurred to a motor the car went

along with the crippled machine or with one good one, oftentimes with the heaviest loads and on the sharpest grades, and in some cases in tow of another car. One hundred and forty men, often with only a day's training, were soon broken in to handle the various parts of the system.

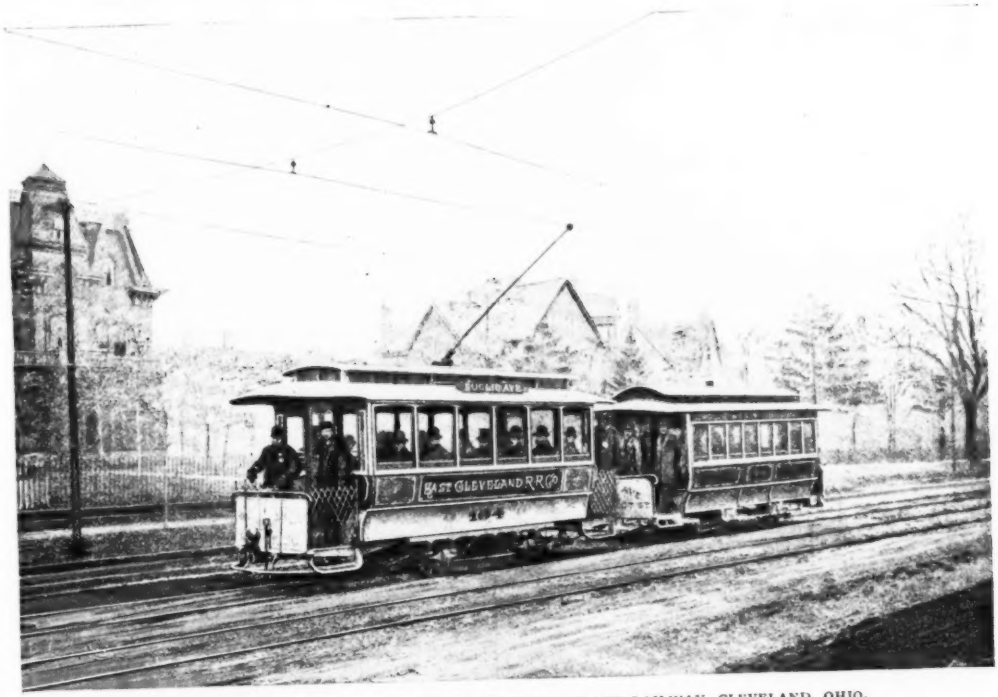
Saturday, May 4, was a red-letter day in our calendar. On that day, in the afternoon, when traffic was heavy, we put on ten additional open cars, finally banking them up near the western terminus. Just at dusk eleven cars at close headway were run at full speed down one of the principal streets, and an hour later thirty cars, many of them heavily loaded, were in full operation. Three boilers, rated at 375



TRUCK OF SPRAGUE CARS.

horse-power supplied not only the railroad dynamos but lighting dynamos with an equivalent load of over 1000 lamps.

The highest reading on the line was less than three-quarters of the normal capacity of the dynamos, and the average reading only one-half. This test settled conclusively all question as to distance, speed, and power, and practically ended the discussion as to the merits of the series and multiple-arc systems of distribution. Fatigue, worry, and expense were all forgotten for the moment, such was the keenness of enjoyment in an assured victory. Subsequently one of the most beautiful sights that I had witnessed for a long time was the assembling of sixteen cars in the center of the town at night by reason of a mistake in the time of ending of an entertainment. This, too, was a most important demonstration upon the public mind of the possibilities in the line of work we were pursuing.



VIEW OF ONE CAR DRAWING ANOTHER ON EAST CLEVELAND RAILWAY, CLEVELAND, OHIO.

Another important experiment in banking cars occurred on the occasion of the visit to Richmond of President Henry M. Whitney and a number of the directors of the West End railroad of Boston, then seriously considering the adoption of the cable system. For lack of better shelter the cars were banked out of doors at the eastern terminus. On this particular night twenty-two cars were so collected.

General-Manager Longstreet, of the West End road, having expressed doubts as to the handling of the cars electrically when bunched together, Burt and I made up our minds we would settle the question by a critical experiment, although it was overtaxing the line many times over. Mr. Whitney had retired, but on receiving word about midnight that we were willing to make such an experiment, he immediately arose and we were soon on our way to the eastern sheds, two miles from the station. The current supply was by two paths over a silicon-bronze wire one-fifth of an inch in diameter, reënforced by another wire of about the same size. We loaded the feeder safety catches, raised the pressure to 500 volts, and ordered the engineer to hold the machines to duty no matter what happened. At the wave of a lantern, 22 motormen as quickly as possible started their cars at the termination of a line calculated for only four distributed cars. The potential dropped to 200 volts, then gradually rose, and soon all the cars were running out of reach of signals. This settled the cable question for Boston, and we shortly secured the contract for the first overhead line in that city.

Richmond was prolific in new experiences which in variety and extent taxed our resources to a degree happily unknown on modern roads. Many were not inherent to the machines or the system, but were caused or augmented by local conditions. One of the most annoying was the jumping of the cars from the track. As has been stated this was not only largely laid in dirt streets, the soil of which was of red or yellow clay, but the curves had only one guard-rail and were not bound in by paving. The winter months brought frequent and heavy rains, the cars were large and heavy, and in a short time the curves spread. Mud and stones would get into the grooves, and, on account of the tangential tendency of the cars, before an inexperienced man could check them they were off the track and the wheels were down several inches in the mud alongside the stringer pieces, and the track-brakes hard fast.

For some time scarcely a trip was made without the cars jumping the track, and a heroic treatment was at first adopted which gave them the appearance of battering-rams. Twelve-foot sticks of timber and scaling-ladders were carried under the car-bodies, and when a car left

the rails and tried to bury itself in the mud, all hands, often aided by the passengers, pried it back into place. Gradually the soft places were filled up with cinders, the track rectified, the curves paved, and we soon learned to get a car back by using track-plates and completing the ground circuit by a flexible cable which we termed an "electric kedge."

The bugbears of sleet, snow, and mud were frequently raised; it was impossible to keep the tracks from being thickly covered by the crowding of the passing vehicles, and when a sharp change of weather occurred at night the cars in the morning would play leap-frog with brilliant pyrotechnic displays. Virginia mud clung hard to cold iron, and it was a common thing to have to cut through clay, snow, and ice when the tracks were completely out of sight.

On one of the worst nights of winter I had gone to bed completely played out after a vain attempt to get the "Snowflake," our construction car, up a 6-per-cent. grade on a slippery track with one motor, and had finally left it in the street for the morning's work. Dawn brought dismay, for tracks, trees, and trolley wire were covered with a heavy sleet. Not a car was in operation, and everything looked hopeless. In desperation I boarded my pet car, swept off some of the snow, wiped off the motors so that there was only a moderate display of leaks, and started to make the best of my way to the power-house. The sun had come out, water was dripping from the pendant icicles, and when I turned the corner at the head of the Franklin-street grade, my astonished eyes were gladdened by the sight of a car slowly climbing the 10-per-cent. grade with Pat on top pounding the trolley wires with a broom and making the sleet drop off in great lengths. That settled the sleet question, and we gave ourselves no more concern on that account.

Thunder-storms are particularly severe in Richmond and this brought us new anxieties. The length of the overhead circuit, the unguarded condition of the wires, and the numerous ground connections offered by lamps and motors invited frequent discharges. We awaited the result of the first attack of the heavens with interest. Like many other anticipated troubles, so far as they related to danger to life our apprehensions were quickly allayed.

In one of the first storms lamps were broken, field-magnets grounded, and switches burned out. On one occasion three men were sitting on the rear platform, one with his legs probably dangling over the switch, when there was a sharp flash and a loud clap, accompanied by a peculiar report in the switch beneath him where the discharge jumped to earth. Three terrified darkies disappearing as fast as their legs could carry them up the street was the sequel. As a rule, how-

ever, little personal difficulty was experienced because of this trouble. Passengers often did not know when the lightning discharged through the car circuits, or, if they did, they quickly got used to it.

We found that the lamp-circuits offered a very free path, so when a thunder-storm appeared the lamps, ostensibly to light the car as was carefully explained to timid lady passengers, were turned on and the lightning given free play. The armatures being on the ground side of the circuit were rarely injured because the fields acted as choking coils and forced the discharge to earth at some weak point. Lightning-arresters without number and with varying degree of success were introduced, but the lightning always remained more or less erratic.

Such are some of the reminiscences of Richmond days. The infant industry of seven years ago has grown to manhood and marks one of the most important of modern industrial advances. Six hundred railroads, 25,000 motors, and an investment of a quarter of a billion of dollars speak of its marvelous growth. The days of the horse-car are limited. The cable is restricted to special localities. In suburban service already the electric car rivals the locomotive, and the latter is being gradually forced to its legitimate field of through trunk-line and freight service.

THE CYANIDE PROCESS OF GOLD AND SILVER EXTRACTION.

By Philip Argall, M. R. I. A.

GOLD was in all probability one of the first metals to attract the attention of primitive man. Its beautiful and permanent luster, its high specific gravity, and its comparative scarceness withal, must have early rendered it an article of *vertu*, the search for which meant labor, and its possession wealth. The vessels of gold found in the Egyptian tombs, together with the drawings on their walls, give evidence of the advanced state of the metallurgy of gold long before the time of Rameses II. The Hebrew scriptures abound with references to the metallurgy of gold and silver, and particularly to the refining or cupellation process, evidently referred to by Jeremiah in: "The bellows are burned, the lead is consumed of the fire, the founder melteth in vain." The early Greeks were familiar with the natural alloy of silver and gold—electrum—rough-stamped nuggets of which formed the earliest coins of Lydia. Mercury, mentioned by the Greek philosopher, Theophrastus, as a derivative of cinnabar (300 B. C.), was used by the Romans in the time of Pliny, both for the separation of the precious metals, and for the purpose of gilding.

Smelting, then, appears to be the older metallurgical process; next would come amalgamation, while hydro-metallurgical methods are apparently of very modern origin. I say apparently, for now that the Egyptian temples, tombs, and ruins, furnish evidence that diamond-core drills, circular saws, hot-blast stoves, etc., were known and used 3000 to 4000 years ago, one cannot be certain that even the cyanide process itself is not a re-invention, at least until the Egyptologists are heard from.

In these degenerate days gold is recovered from its ores by amalgamation, by smelting, or by hydro-metallurgical methods. The first-named process is seldom entirely satisfactory, as the extraction is invariably more or less imperfect. It is therefore usual to precede or follow amalgamation with a process of concentration, to remove the heavier minerals that do not readily yield their gold to mercury. The concentrates so obtained are treated by the smelting process, or by hydro-metallurgical methods.

Smelting* gives the highest practicable extraction of gold and

*Lead-smelting was described in the March number of this Magazine by Mr. W. R. Ingalls, and pyritic-smelting in the April number by the present writer.

silver from their ores, but usually at the greatest cost, while amalgamation—taken by itself—is the antithesis of smelting, as it may be said to give the lowest extraction at the least cost; nevertheless, on low-grade silicious ores, it is the more profitable of the two methods, and the one in general use.

The hydro-metallurgical treatment of gold-ores has been steadily gaining ground for several years past, not alone in the treatment of concentrates and tailings, but also in the direct treatment of auriferous ores. Where the gold, by reason of its extreme fineness or the allotropic modifications of its molecules, or for other causes, will not amalgamate, and where the economic conditions that obtain do not permit smelting, recourse has usually been had to hydro-metallurgical methods, noted examples being the Mount Morgan mine in Queensland, where amalgamation gave such poor results that it had to be abandoned in favor of chlorination, and the Mercur mine, in Utah, where amalgamation is said to have extracted but 25 per cent. of the gold in the ore, at an expense of $4.25 per ton, while the cyanide process that replaced it is reported to give 80 to 85 per cent. of the gold, at a cost of $2.40.

Chlorination has held hitherto the first position among hydro-metallurgical methods of gold extraction, but it must now take a second place in favor of its powerful rival, the cyanide process, if measured by their relative gold production. The cyanide process, while suitable to perhaps the majority of gold-ores, is not applicable to all. On certain classes of ore, and under certain well-known conditions, chlorination will give better results than will cyanide, and again the converse is true. Each process, then, has its field, at present perhaps but ill-defined, but which will shortly be marked with precision.

It is generally supposed that certain classes of sulphid and telluride ores which do not yield their gold to cyanide solutions within reasonable time, or with a reasonable expenditure of chemicals, should be treated by the chlorination process; it being argued that once it becomes necessary to roast the ore, chlorination is cheaper than cyaniding. This supposition is not strictly correct. Careful experiments have shown that such ores are often amenable to cyanide treatment after an extremely light roast, and that with proper expedients the consumption of cyanide in leaching the roasted ore is not abnormal. To chlorinate these ores a dead roast is a prime requisite, while the expense of the subsequent chlorination treatment will, in most cases, exceed the cost of cyaniding. Another important feature: the chlorine will extract gold *only*, while cyanide invariably extracts a large proportion of the silver in the ore, in addition to the gold.

The cyanide process is based on the solubility of gold and silver

in solutions of potassium cyanide (KCN); this salt is composed—as shown by the formula—of potassium, carbon and nitrogen, though the symbol Cy is commonly used, instead of the formula CN, to represent the radical cyanogen, which combines like chlorine with hydrogen and the metals. Roscoe compares its compounds with those of chlorine thus:

Hydrocyanic acid, CyH.	Hydrochloric acid, ClH.
Potassium cyanide, CyK.	Potassium chlorid, ClK.
Potassium cyanate, CyOK.	Potassium hypochlorite, ClOK.
Free cyanogen, Cy_2.	Free chlorin, Cl_2.

Hydrocyanic acid is so weak an acid that its soluble salts are readily decomposed by the carbonic acid of the air. Potassium cyanide is no exception to this rule, as its solutions decompose in contact with the air, and smell of hydrocyanic acid. Any weak acid or acid salts will also decompose cyanide solutions, and to this fact many of the chemical difficulties in the application of the cyanide process are due. If the ore is acid, it causes an increased consumption of potassium cyanide, and as this salt costs 50 cents per pound, any abnormal consumption cuts rapidly into the margin of profits.

It has long been known that gold is soluble in cyanide solutions. Hagen, for example, pointed out in 1805 that gold is dissolved not only by free chlorin and *aqua regia*, but also by a potassium cyanide solution. Glassford, Napier, Gemelin and others mentioned the solvent power of cyanide on gold and silver, in the early part of this century. The classic experiments of Faraday on the relation of finely divided gold to light are well known. Suffice it to say, that films of gold-leaf of extreme tenuity were obtained by spreading the leaf gold on glass plates and subjecting them to cyanide solutions. Roseleur also pointed out that solutions of cyanides "rapidly dissolve in the cold, or at moderate temperature, all the metals except platinum."

Although the solubility of gold in cyanide solutions is no recent discovery, and although several attempts appear to have been made to introduce a process having potassium cyanide—usually in combination with another salt—as a solvent for the gold, it remained for Messrs. McArthur and Forrest to introduce a commercially-useful process for treating ores with cyanide solutions. This process has been extremely successful in South Africa; fairly successful in some other countries, and until recently has been, on the whole, rather unsuccessful in the United States.

The cyanide process in South Africa has been used almost exclusively in the treatment of tailings from the stamp-mills, in which ordinary battery-amalgamation is practiced. The ores, while unfavorable for efficient amalgamation, are particularly suitable to cyanide treat-

ment, consisting of silica and iron oxid almost to the exclusion of any substance—except gold or silver—soluble in cyanide of potassium solutions. As the reefs are followed downward, however, pyrite replaces the iron oxid and the ores become base—with what result on the cyanide process remains to be seen. One of the largest mines in South Africa (the Robinson) has for some time treated the pyritic concentrates from the stamp-mills by the chlorination process, while using the cyanide process on the tailings. During the half year ending December 31, 1893, this company milled 94,842 tons of ore with the following result:

	Ounces.	Percentage.
Gold produced from milling	104,223	78.5
Gold produced by chlorination of concentrates.	10,660	8.0
Gold produced from tailings, cyanide process.	17,992	13.5

The cost of cyaniding the tailings amounted to $1.57 per ton, distributed as follows:

Wages and supplies	$0.899
Cyanide	0.483
Zinc	0.026
Royalty	0.163

[The extraction is reported at 68.7 of the contained gold.]

During the same half year another South African company (the Durban-Roodepoort) treated 79,765 tons of tailings by the cyanide process at a cost of $1.53 per ton and profit of $2.77 per ton. The extraction varied from 67 to 85 per cent. of the gold.

The South African Gold Recovery Company, which controls the cyanide process there, reports the extraction in the Transvaal for the month of May, 1894, at 57,850 ounces of gold, and states that the process is producing 30 per cent. of the total yield of gold in the Witwatersrand district. During the five months ending May last, the cyanide process alone produced 273,450 ounces of gold in the Transvaal. It must be noted that the fineness of the gold is not stated. I find, however, that the cyanide gold averages about $15 per ounce,—say .726 fine,—while the mill gold of the district is about .867 fine,—say, about $17.90 per ounce.

The foregoing figures show conclusively that the cyanide process, under favorable conditions, is capable of accomplishing very wonderful results, and that it has made more rapid strides than perhaps any other process hitherto introduced for extracting the precious metals from their ores. We must not, however, lose sight of the fact that the process is applied in South Africa to the treatment of battery sands, from which the extremely fine slime has been removed; the process is not, therefore, charged with the crushing or preparation of the ore,

while the material operated upon is of comparatively low value, say $5 to $7 per ton, giving a final tailing value of $1.50 to $2.00 per ton.

Seeing that the cyanide process has had its greatest development and achieved its best commercial success as an auxiliary to amalgamation, the question arises, can ores be treated direct with cyanide? Is the cyanide method complete in itself, or merely a new step in the successful treatment of gold-ores? It is both. For example: When the gold in the ore is coarse and granular, amalgamation either before or after the cyanide treatment is imperative. For it is well known that cyanide solutions (in common with chlorin) take a very long time to dissolve coarse gold. If, however, the gold is fairly fine, cyanide usually answers all requirements, and with suitable ores, properly prepared, gives a high rate of extraction at moderate cost and in reasonable time. In some cases, then, ores can be directly treated by, and finished with, cyanide; while with other ores, amalgamation is a necessary step in order to remove coarse gold, shorten the lixiviation part of the process and reduce the consumption of cyanide, which, after the first half hour, increases in proportion to the time its solution remains in contact with the ore. In other cases concentration is advisable. For example: An ore may contain 15 per cent. of pyrites, which may require special treatment in the way of a stronger solution, or long exposure to solution—say 80 hours—in order to obtain a good extraction; while the remaining 85 per cent. of the ore may have its gold dissolved in twenty-four hours. Here, then, separating the heavier from the lighter particles, and subjecting each to separate treatment, will result in a gain of time in lixiviating, saving of chemicals, and increased capacity of the works.

The same line of argument holds good if the concentrates cannot be successfully treated by cyanide, as in this case a deleterious material is removed from contact with the cyanide solution, to be handled by such other methods as the particular circumstances will indicate. The cyanide process, then, can be applied to ores direct, or as a combination process with amalgamation or concentration, or both, as may be found most convenient and profitable for the economic treatment of the ores.

For the purpose of description, the cyanide process can be conveniently divided into four distinct stages or steps: (1) The preparation of the ore; (2) solution of the gold; (3) precipitation of the gold from solution; and (4) converting the precipitate into bullion.

1. The preparation of the ore consists in reducing it to the size necessary to give the desired extraction. This size varies considerably in accordance with the character of the ore, but may be said to run from 20 to 60-mesh. The ore is usually crushed dry, though wet-

crushing is sometimes practiced, and on some ores presents decided advantages over the dry method. The ore must be crushed so as to produce a fairly even and granular material, as free as possible from dust when dry-crushing is practiced, and equally free from slime if crushed wet. This granular product is not easily obtained from the crushing-plant usually adopted, and to this fact most of the failures of the cyanide process in the United States are due. We hear in such cases that the extractions in laboratory tests were highly satisfactory, and indeed that the mill extractions were also excellent but "the ore would not leach," therefore, while the gold was readily obtained in solution, it was impossible to separate the auriferous solutions from the pulp, and hence the alleged failure of the process. I will give two instances by way of illustration: A certain mill, abandoned as a failure on account of leaching troubles, proved on investigation to have crushed 67 per cent. of the ore fine enough to pass through 200-mesh—0.0025-inch openings—while ostensibly crushing to 30 mesh. In another case, I found that 42 per cent. of the pulp would pass 200-mesh. In both cases, leaching was impracticable. Proper machinery was afterward placed in these mills, with the result that the former produced a pulp having only 8 per cent. passing 200-mesh, and giving a leaching rate of 8 to 12 inches per hour; the pulp produced from the latter mill gave also a very excellent leaching rate. Both mills are now running satisfactorily.

Successive comminution is the correct principle to adopt for the preparation of pulp for the cyanide process. The best results hitherto obtained, on rather friable oxidized silicious ores, have been produced by the following series of machines: (*a*) an ordinary Blake crusher, which reduces the ore to about 1½ inches; (*b*) a three-jaw multiple Blake crusher, which brings the ore down to ¾-inch; followed by (*c*) a five-jaw multiple that reduces it to about 6-mesh; and (*d*) rolls that finish the pulp to pass a 30-mesh screen. The ore is screened after each crushing, so that the portion reduced to the desired fineness passes direct to the finished-ore bin, instead of—as is too often the case—going to the next machine to be reduced to a further and unnecessary degree of fineness. This plant, crushing to 30-mesh, produces only from 5 to 10 per cent. fine enough to pass 200-mesh.

Soft, clayey ores have hitherto given much trouble, and, in fact, it is usually impossible to leach them, not alone on account of the dust produced in reducing such ores to pulp, but often because of the amount of dust existing in the ore before crushing. These difficulties have been overcome by separating from the pulp such an amount of dust as is found necessary to give a good leaching rate, and subjecting this separated dust to a special treatment. It has been found that the

removal of as little as 5 per cent. of the extremely fine dust will often give a fair leaching rate on pulp that before its removal could not be leached; while the worst case I have met with did not require the removal of over 15 per cent. of this dust in order to obtain a good percolation rate.

The preparation of the ore, then, is a very important step in the direct treatment by the cyanide process, and one that has only been brought to its present state of perfection within the last six months.

II. The solution of the gold is effected in leaching tanks, which are preferably constructed of steel. These tanks are made from ten to forty feet in diameter, and from three to four feet in depth. Some prefer wooden tanks, as the cyanide solution attacks steel—very feebly, it is true—and gold may be precipitated on the sides of the tanks. These objections are quasi-theoretic and have no practical bearing on the process. It has been proved that steel tanks coated with paraffin paint meet all practical requirements, and are the best to use under all conditions.

The leaching tanks are fitted with filters in the usual manner; side or bottom discharge-gates are provided for sluicing out the tailings. A leading and return pipe of iron should be provided for each solution used in lixiviating. The granular ore is charged into the leaching tanks to the depth of two-and-a-half to three feet. The ore, of course, varies in weight in accordance with its composition; about 80 pounds per cubic foot, however, is a fair average. On this basis, a 40-foot tank would hold 50 tons per foot of depth, while a 20-foot tank would hold 12.5 tons per foot. A small tank for dissolving the cyanide, large storage tanks for weak and strong solutions and for wash water, are part of the equipment of the leaching department.

To obtain the best results, the ore should be neither acid nor alkaline; if the former, it decomposes the cyanide solutions in the leaching tanks, and, if strongly alkaline, it causes an increased consumption of zinc, and, indirectly, of cyanide in the precipitating boxes. When ore gives an acid reaction, lime is sometimes added to it in the crushing machines, or the pulp in the leaching tanks is treated with an alkaline solution, or with water to dissolve the acid salts. After the preliminary leaching with water or alkaline solution is completed, cyanide solution of the required strength—usually 0.25 to 0.50 per cent. for gold ores, and 0.60 to 1.50 per cent. for ores carrying much silver—is admitted below the filter and allowed to slowly percolate upwards and rise to a height of three inches above the upper surface of the charge. This solution is allowed to stand on the ore from eight to twenty-four hours and is then drawn off and passed through the precipitating boxes. Weak solution is then added and

lixiviation continued until the maximum extraction is obtained, when wash water is introduced above the charge to displace the weak cyanide solution. The discharge-gates are then opened, the pulp sluiced out of the tank and the next charge added.

Agitation of the pulp and cyanide in open vessels was the method originally proposed. This method has, however, not proved very satisfactory because of the heavy loss of cyanide through decomposition, caused chiefly by the admixture of air with the solution, and also on account of the difficulty in separating the solution from the pulp. Agitation, however, invariably gives a better rate of extraction and procures the solution of the precious metals in fully one-third less time than is usually occupied in tank lixiviation; moreover, some ores, such as those carrying their principal values in silver, or gold and silver sulphids, or tellurides, often fail to give a satisfactory extraction by the lixiviation method, while by agitation they are readily beneficiated.

By the use of barrels instead of open vessels, and with ores properly prepared in granular form, the agitation process will no doubt be revived and will, I believe, yet become the leading method for the direct treatment of ores in the United States.

III. The gold is precipitated from the cyanide solution by means of zinc shavings so placed in the precipitating boxes that the solution, in flowing through them alternately, passes upwards and downwards through the loose mass of zinc. These boxes are usually made of wood, but could with advantage be constructed of glass, earthenware, or cement. No iron or metal other than zinc should be exposed to the solutions in the boxes; even the iron-wire screens used to support the filiform zinc have been shown by Mr. N. Andersen, of Denver, Colorado, to cause an unnecessary consumption of zinc and cyanide, through the electrochemical action induced between the metals.

The precipitation boxes are made in lengths varying from 40 feet down to 5 feet. Long boxes are a mistake. They should in no case be longer than is necessary to precipitate the gold from solution,—a result that can be readily obtained in an 8-foot box. The exposure of the solution to the zinc after the gold is precipitated only can result in a loss of zinc, and what is of much greater importance, unnecessary decomposition and loss of cyanide. The cyanide solution, after passing through the precipitating boxes is pumped back to the storage tanks and brought up to the required strength by the addition of strong solution from the dissolving tank. The standardized solution is then ready for use in the leaching tanks. The solution, then, is used continuously and not run to waste when the gold is precipitated as are the solutions from chlorination works. The zinc dissolved in the precipitation boxes does not accumulate in the solution beyond the fraction

of 1 per cent. As we do not find that zinc accumulates in the storage tanks, it is probably precipitated in the lixiviation tanks in contact with the charges of fresh ore.

IV. The bullion is produced as follows: The precipitation-boxes are cleaned up and the coarse zinc separated from the fine precipitate by screening in water; the precipitate is then treated with sulphuric acid to dissolve the fine zinc which it usually contains in considerable quantity. The residue is then washed, dried, melted in crucibles with the proper flux, and the bullion cast into bars for shipment to the mints. This method is at best, however, tedious and beset with many difficulties. It should never be attempted without the proper apparatus, which must always include an exhaust fan to remove the noxious gases evolved from the acid treatment. The dried precipitate is occasionally shipped direct to the large smelting and refining works, such as the Omaha and Grant, at Omaha, Nebraska. With small mills this may, on the whole, be the cheaper method to pursue. Sometimes the precipitate (freed from coarse zinc by screening) is dried and melted down in crucibles, producing, however, a very base bullion. This is the method invariably practiced in South Africa, where weight in ounces, and not quality of bullion, appears to be the desideratum. Experiments are now in progress looking towards the refining of the bullion and shipment of fine gold bars and silver residues from the cyanide mills; they show a tendency toward the best practice in this country.

Such is, in brief, the *modus operandi* of one of the most successful hydro-metallurgical methods for the economical treatment of medium-grade gold- and silver-ores. Any attempt to enumerate the ores amenable to cyanide treatment is (apart from its impracticability) entirely beyond the scope of this article; carefully conducted laboratory experiments should alone be the guide in every instance. When these experiments are successful, they can with certainty be followed with equally successful milling.

A first-class cyanide plant, complete in all its details, costs, for a capacity of 50 tons per day, about $25,000; for 100 tons daily capacity, about $40,000.

The cyanide process is often claimed to be an extremely simple one. With a properly constructed plant, efficient metallurgical supervision and skilled labor, it *is* as simple as any other well-managed metallurgical process; but in inexperienced hands it almost invariably proves to be profoundly complicated and extremely disappointing. Mills must be provided that will granulate the ore, chemists who understand the conditions necessary to effect a good extraction, and men who know how to charge tanks for lixiviation and keep filters in working order.

THEATER-BUILDING FOR AMERICAN CITIES.

By Dankmar Adler.

SECOND PAPER.

THE comfort of an audience and its enjoyment of a stage performance are largely affected by the arrangement and character of the seating. Here there is an ever-present conflict between the desire to get as many people into a given space and the wish to make them comfortable after they have been got there. Observation of existing conditions teaches that, if the audience is to be comfortable, the width of the seats should be from twenty inches upward and their distance from back to back from thirty-two or thirty-three inches upward, and that upon floors which have high steppings the distance from back to back should be greater than where the floor is more nearly level. Complicated mechanisms of folding chairs have always been a source of annoyance after the effect of their novelty or apparent ingenuity has worn away. Elaborate upholstery, unless of the very best quality, has also proved the cause of much vexation to owners and managers of theaters.

Aisles should be placed at small intervals, and in that case—if, say, only six seats apart—they need only be wide enough to permit two persons to walk abreast with comfort. Six aisles each three feet in width are better than three aisles each six feet wide, although the latter may be much more impressive.

A rational and consistent system of section- and seat-numbering is of great help to ticket-sellers, to ushers, and to the public, and is a safeguard against many annoyances in ticket-buying, in seat-finding, and in the enjoyment of the possession of the seat after it has been found. Of course every seat, including the seats in the upper gallery, should be numbered, and every ticket sold at the box-office should call for a definitely-designated seat.

The lighting of an auditorium, like almost every other point in theater-design, presents many conflicting conditions. During the performance, the house must not be too brilliantly lighted or its illumination will dim that of the stage, yet the house must be kept so well lighted that the play-bill may be easily read. When the curtain is down the illumination must be brilliant enough to allow display of rich toilets and to promote the sparkle of jewels, but it should not cast deep shadows, nor dazzle the eyes, and it should be all-pervading and equally diffused. As we are gaining experience in the use of the electric light, all this will become more and more easy of attainment.

Electric lamps can be applied almost anywhere, and can therefore be so arranged as to throw light of the right quantity and quality upon almost any object and yet still be themselves kept out of range of direct vision.

While these things are possible of attainment, they have not yet been attained. We are still too much hampered by the traditions of gas-lighting, and perhaps also to some extent by a practice, invented and introduced by myself, of using the incandescent electric lamp as a component part of the decoration of the theater. This practice seemed charming when it was new, and is still found so while the lights are turned low, and for the first few minutes after they are turned up, but soon after it becomes trying to even the strongest eyes and positively distressing to weak eyes. It may be that the solution of the problems encountered in the effort to obtain an effective and agreeable system of theater-lighting is to be found in the combination of the decorative effect of dimly-burning incandescent lamps with the reflected light of properly distributed and concealed arc-lamps, with which I experimented some years ago. Success was not attained in that instance, chiefly because of the jealousies of two different sets of contractors for electric-lighting. It may be well to add here that the lamps in halls and corridors should be kept burning full strength even when those in the auditorium are turned low, but that care must be exercised to prevent the hall and corridor lights from shining into the theater itself at such times. Great attention must be paid to the means of controlling and graduating the lights and in the arrangement of circuits and switches; and economy of current used by the janitors must not be lost sight of. The accessibility of the lamps for purposes of cleaning and renewal also demands the attention of the architect and may seriously affect certain features of the design.

The color decoration of a theater should be studied in connection with its illumination and also with a view to avoiding conflict in brilliancy and interest between auditorium and stage. The architect should not lose sight of the fact that the stage must be the center of attraction in every theater.

In the main, colors which act to any great extent as absorbents of light should be avoided, and those which, in contrast with the light absorbing tints may be called light reflectors, should be given the preference. Yet while the use of lighter tints tends to impart a festive and brilliant air to the house, they are apt to conflict with the toilets and complexions of many ladies in the audience; and if darker tints are used the house will be somber and wanting in that festive brilliancy which should characterize the artistic treatment of a place of public amusement.

While it is possible to strike a happy mean between these divergent requirements, it has not often been done, and the architect who succeeds in so managing the illumination and decoration of a theater as to at once satisfy both the wearer of fine toilets and of beautiful complexions and the artistic sense, has abundant cause for self-congratulation.

The use of richly-modulated plastic surface ornament is an important aid to successful color decoration. It gives a rare interest to even the simplest scheme of color distribution by the introduction of modulations of light and shade, by the constant variations of perspective effects, and by the brilliancy of the protuberant points and edges as they catch and reflect the light. This interest may be still further enhanced by the use of carefully designed and modeled figure sculpture in low relief or even in moderately high relief.

The entrances and exits and all means of internal communication of every theater should be broad, commodious, and direct. So-called emergency-exits are of no value unless they are open every night, and then only when an active effort is made by the ushers at the close of every performance to induce people to use them. The tendency of an audience is to leave the house by the ways through which it has entered, and the use of emergency-exits will never be thought of by the transient theater-goer unless there is a large number of habitues of the house to lead the way, and these can only be taught to do so by the constant and unremitting efforts of the management. The English practice of having a separate entrance and a ticket-taker for each of many subdivisions of the house has the advantage of making the audience familiar with many means of exit and of thus preventing a rush to a single main entrance and exit as is the practice in the United States. The stairs, halls, and corridors should have a set of emergency lamps always kept burning while the house is in use, but having a source of supply and regulation independent from that of the auditorium and stage.

Real and popular success in heating and ventilating a theater is even more difficult of attainment than in its lighting and decoration. People consider a theater well ventilated if in warm weather they are kept very cool and in cold weather they are kept moderately warm, and their judgment is little if at all influenced by the extent to which the air is actually changed and renewed. The temperature which people consider respectively warm or cool varies by at least ten degrees in different individuals at the same time, and is subject to the same range in the same individual at different times under variations of mood and physical condition.

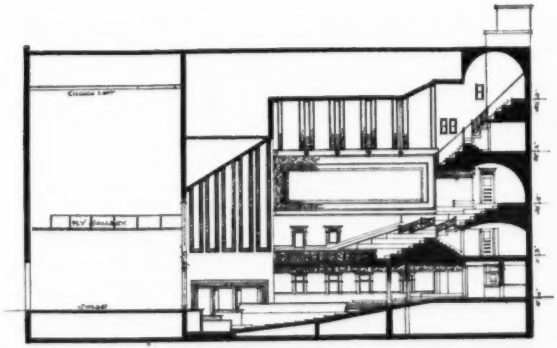
We meet at the outset, therefore, an insurmountable obstacle to the

adoption of a generally satisfactory standard of temperature and are sure that, whichever standard we adopt, it will be unsatisfactory to many persons in the audience. But after a standard temperature has been determined upon, it is difficult even with the most perfect apparatus and under the most favorable conditions to maintain it. At whatever temperature the air is admitted into the house, contact with the lights and with the bodies of the people will quickly raise it. The brilliancy of the illumination and consequently its heat-radiating powers vary from time to time during the same performance and of course from play to play, while the sizes of audiences are subject to nightly change. Coincident with these changes are variations of external temperature and of barometric and hygrometric conditions of the atmosphere, as well as of wind direction and velocity and these variations of external conditions occur irregularly as to time, character, and extent, and sometimes run a gamut of changes during a single performance to the utter confounding of even the best managers and engineers.

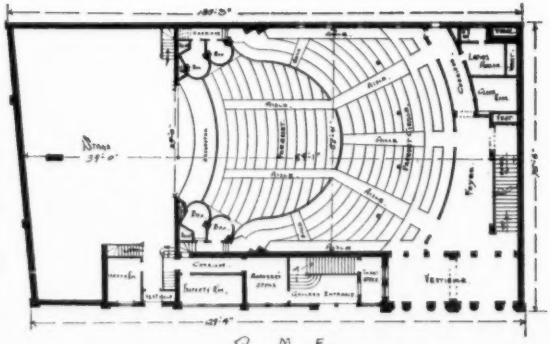
If a theater could be effectively sealed to all influx or efflux of air, except as it is introduced and removed by the ventilating apparatus, and if ingress and egress of audience and actors were effected through air-locks or through doors the use of which would not be permitted during the performance, it would be possible to maintain within its walls atmospheric conditions very closely approximating a fixed standard of temperature, pressure, and moisture. If also an audience could be so selected as to have it composed of people approximately of uniform physical and mental peculiarities, to which select audience the thermometric, barometric, and hygrometric standard of the theatre has been adapted, approximate success might be attained.

In designing and operating the heating and ventilating apparatus of a theater all thought of satisfying cranks and hypochondriacs must be abandoned. A standard temperature satisfactory to the average healthy human being must be determined upon, and adhered to as closely as possible.

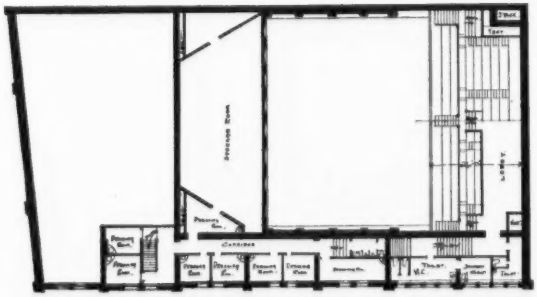
As ventilation through doors and windows is practicable only for small rooms, and then only in warm weather, the movement of the contained air by mechanical means becomes a necessity. But as the range of successful operation of mechanisms does not extend far beyond the conditions for which they have been designed, it becomes necessary to see to it, that the room to be ventilated has no means of communication with the outer air other than those which form part of the ventilating system. This banishes open windows entirely, and makes it desirable that there be inserted as many sets of doors between the street and the theater as it is possible to find room for. There should never be less than three sets of doors, and four or more would be better.



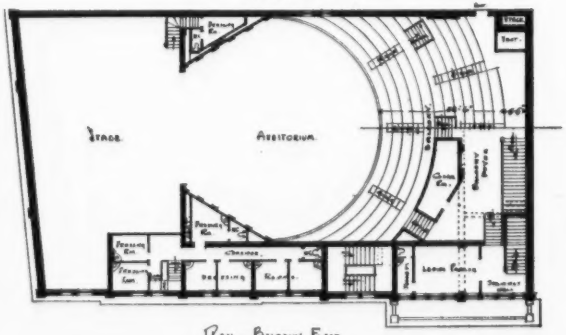
Longitudinal Section



Plan of Main Floor



Plan of Gallery Floor



Plan of Balcony Floor

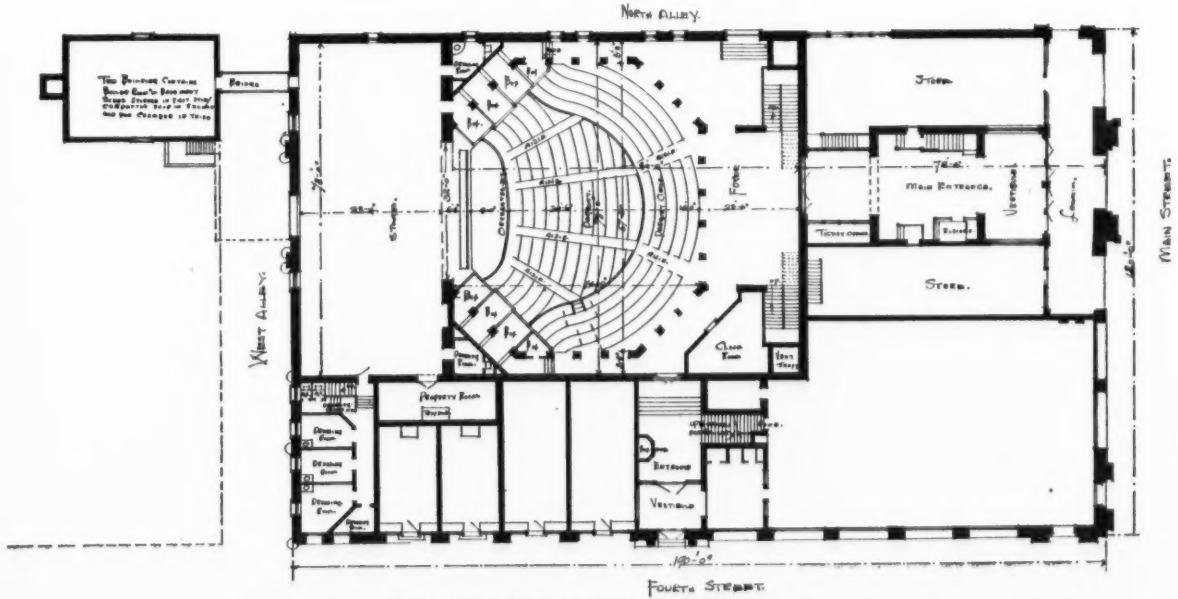
DEUTSCHES STADT THEATER, MILWAUKEE, WISCONSIN.

These doors should not be too near each other; we must minimize the likelihood of having them all open simultaneously. The vestibules or lobbies between the successive sets of doors should be well warmed, in order that the rushes of air, which will in spite of precautionary measures sometimes come into the auditorium, may not take the shape of cold drafts. If the house has windows or skylights, they should be double or triple, so as to prevent the precipitation of excessively cooled air into the room.

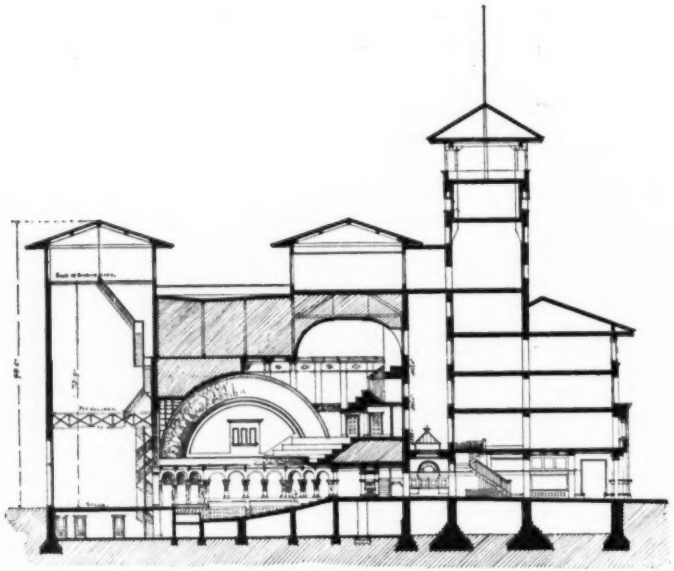
Having as far as possible eliminated possible elements of disturbance and interference, the actual work of ventilation begins. This involves the conveyance, to every part of the room, of fresh air in sufficient volumes for health and comfort, and the removal of a corresponding volume of air after it has performed its intended functions. The fresh-air supply should reach every person in the house and should be approximately constant in temperature, volume, and velocity, nor should its velocity ever be sufficiently great to make itself perceptible as a draft. To accomplish all of this, the ducts for both admission and removal of air must be very large and the openings from the ducts into the rooms quite numerous and very much diffused. Particular attention should be paid to the space under galleries and to all parts of the house which are apt to be used for "standing room," so as to be sure of a rapid movement of the air in these places. It is always well to admit fresh air to the stage and to all dressing-rooms, but while the curtain is down the air-supply to the stage should be reduced.

Before the advent of the electric light it was necessary to admit fresh air for the most part through the floors and to exhaust through the ceilings, a practice still much followed. Such air-inlet openings become receptacles for dust, the coolest air in the room is at one's feet, and the slightest excess in velocity of air movement is felt as a draft about one's ankles. Since the electric light has come into use it has become possible to admit the air at the ceilings and to exhaust it at the floor. This prevents the blowing back into the room of sweepings and places the feet of the audience within the warmest air in the house, but excessive velocity of the fresh air-supply is apt to be the source of serious discomfort to baldheaded men and bare-shouldered women, a difficulty which can be avoided only by extreme diffusion of air inlets and outlets and the prevention of disturbing air-currents from doors and windows.

Ordinary disk fans and pressure-blowers are the motors best adapted to the purpose of theater-ventilation and they may be driven by steam-engines or by electric motors. Their wheels should be very large and the propelling motors should be constructed so as to be capable of operation at varying speeds.



PUEBLO OPERA-HOUSE BUILDING—MAIN FLOOR.



PUEBLO OPERA-HOUSE BUILDING.
[Longitudinal Section.]

In smoky or dusty neighborhoods the air can be forced through a shower of water before it is driven into the building. This shower can be cooled with ice or brine in summer, by which means quite a reduction in temperature can be effected.

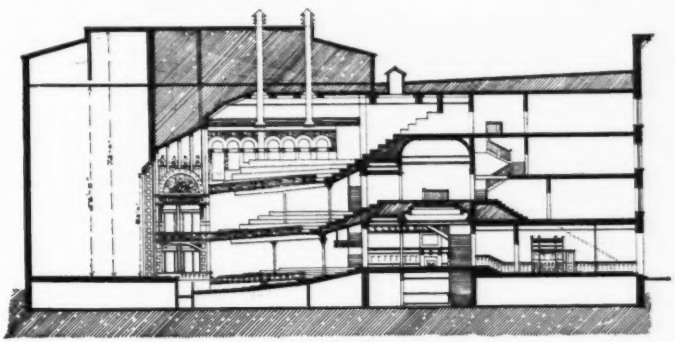
The temperature of the air forced into the house in winter can be regulated by turning the steam into a greater or less number of heating coils, through which coils the air passes before it enters the room. A further means of regulating the temperature of the fresh air is found in the use of a switch-damper, the position of which determines what proportion of air shall pass over the steam-coils and what shall pass into the house unwarmed. For the purpose of mixing the air of the two temperatures and sending it all into the room at a uniform temperature, these coils and dampers should be placed on the out-door side of the fan. All regulation of valves and dampers may be effected either by hand or by an automatic apparatus, the operation of which is governed by the temperature.

Control of the humidity of the air is easy when moisture must be added to maintain the established standard; but to reduce the atmospheric humidity is a very difficult and expensive matter, and, except to

the slight degree possible of accomplishment by the agency of a very cold shower, requires a system of pipes in which a circulation of some freezing fluid is maintained.

When the electric light was first applied to the illumination of theaters, it was thought that danger from fire would be greatly diminished, and that a theater constructed with wood framing and lighted by electricity would be as safe as one of "fireproof construction" lighted by gas. Experience has demonstrated that the introduction of the electric current will not diminish the risk of fire, and that the use of combustible material in the structure of a theater is fraught with as much danger as before, and that there is as much reason as ever why theaters should be built entirely of incombustible materials.

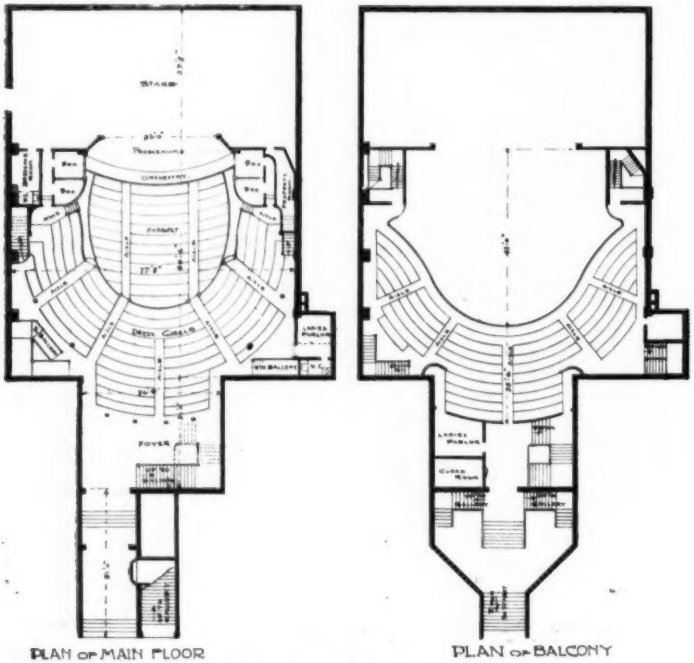
Of the many admirable systems of fireproof construction developed in modern building practice none is better adapted to the requirements and peculiarities of theater-construction than those which use for floor and ceiling construction a combination of rolled steel, metallic laths, concrete, and plaster. Upon the stage, however, the material must be confined to rolled steel beams for the main structural members and to flat iron or L or T iron for the floors of fly galleries and rigging loft. Wire cable can be used to a great extent for the support of drops, border lights, etc., thus confining the use of inflammable material to the heavy planks which, bolted to steel beams, form the stage floor; also to the properties, the drops, the borders, set pieces, etc., of the scenery, and the floors of the drops and bridges, the framework and guides of which may, however, be of metal. Experience has shown less actual permanent value than is claimed by their advocates, in the use of the various fireproof paints and compositions sometimes applied to the lighter and movable combustible parts



GRAND OPERA-HOUSE, CHICAGO.
[Longitudinal Section.]

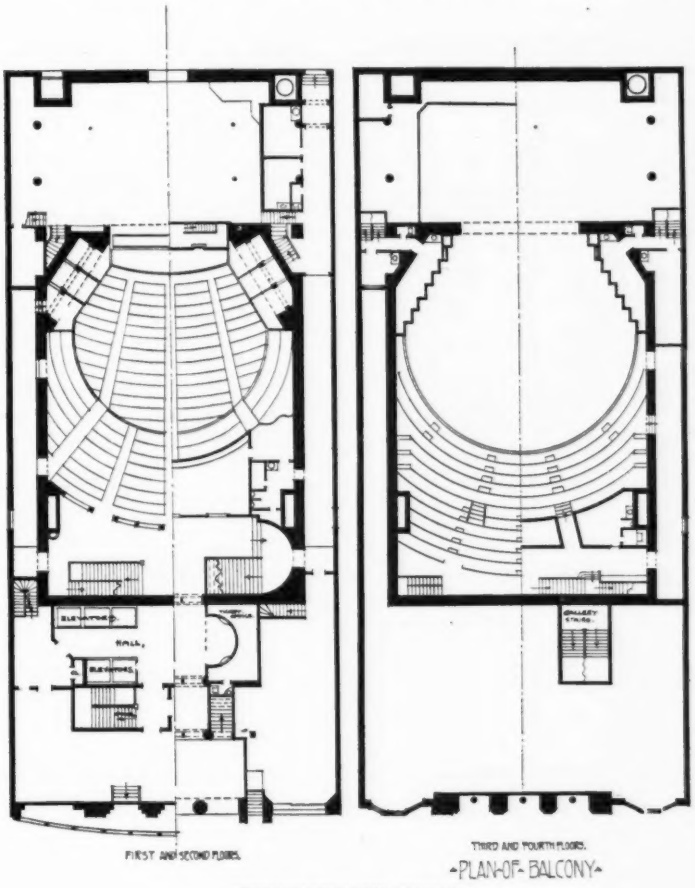
of the stage equipments, for they are handled so often and so roughly, and are so frequently altered and patched, that much of this paint is rubbed, shaken off, or planed off very soon after its first application. A further difficulty, when the canvas is coated with a fire-resisting composition, is found in its deleterious effects upon the pigments used. Still it cannot be denied that these compositions are of some utility, and that for the stationary combustible material which may form part of the stage and its appointments their value is quite positive and permanent.

Returning now to the auditorium and the use of incombustible materials, it is well to remember that the use of hard and unyielding materials for forming enclosing surfaces must be avoided, and also to bear in mind the fact that plastering on metallic laths fastened to a light iron framework has demonstrated its value as a material possessing sufficient resonance for use in this connection. That stairs, corridor floors, walls, and support should be incombustible goes without



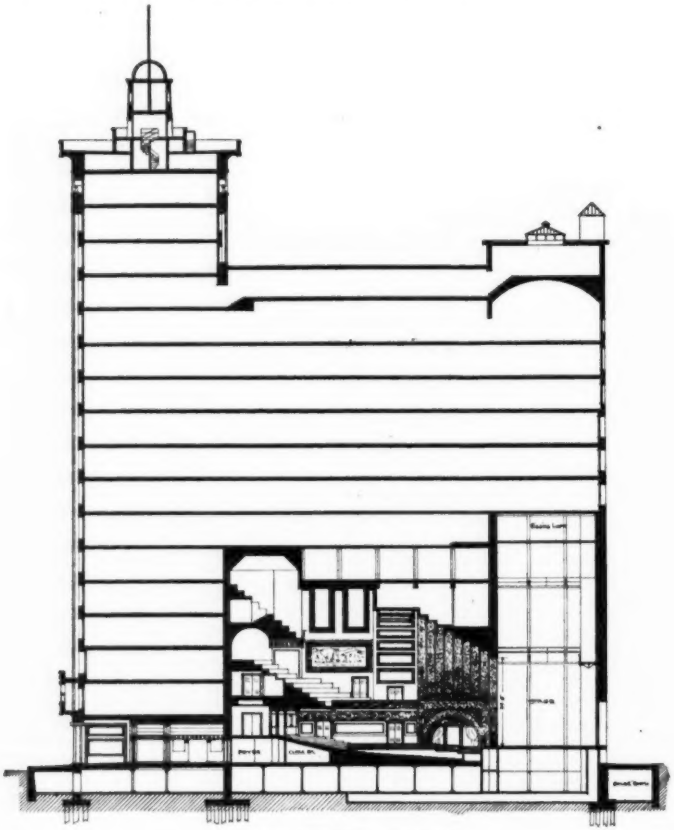
PLAN OF MAIN FLOOR PLAN OF BALCONY

GRAND OPERA-HOUSE, CHICAGO.



SCHILLER THEATER, CHICAGO.

saying. Wherever possible, girder and cantilever constructions should be used in preference to pillars for supporting galleries, so that the lines of sight in the lower parts of the auditorium may be unobstructed. The roof girders and trusses as well as girders, beams, and posts generally should be fireproofed. Where there is danger of knocking off the fireproofing material of pillars, on the stage, in store-rooms, etc., there should be an outer protecting shell of sheet iron. There should be a special contrivance for holding the fireproofing on the



SCHILLER THEATER, CHICAGO.
[Longitudinal Section.]

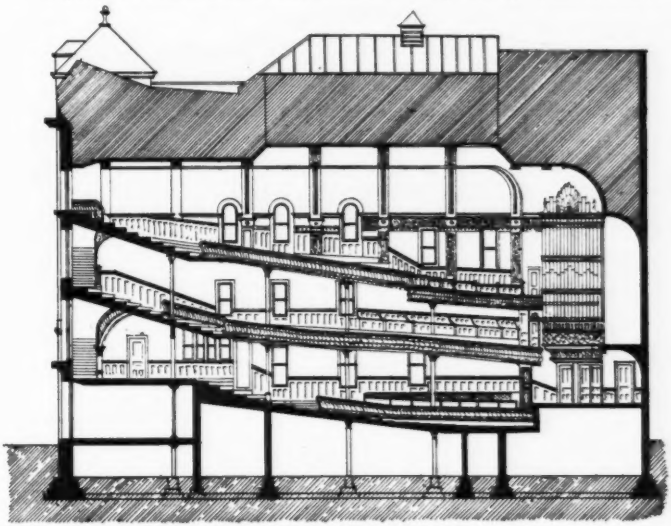
trusses, girders, etc., in such manner that a powerful stream of water from a steam fire-engine may not force it off and expose the metal to the flames.

Equally important with fireproof construction are precautionary measures for checking incipient fires. Stand-pipes should be extended to every space in or about which a fire might originate. Reels of hose should be in readiness at all of these places. The stand-pipes should be connected with the steam pumping-apparatus of the building and should have openings on all adjacent streets and alleys convenient for

connection with steam fire-engines. Chemical fire-extinguishers should be made and maintained as part of the stage equipment. Very large smoke-escape ducts, having suitable dampers controlled from the prompter's stand, should be incorporated with the equipment of every stage. If the manager will institute frequent fire-drills, participated in by all of the theater employés, so that each person employed by the house will know what to do in case of fire and will from force of habit do the right thing at the right time, danger from destructive fires in theaters will have been greatly reduced.

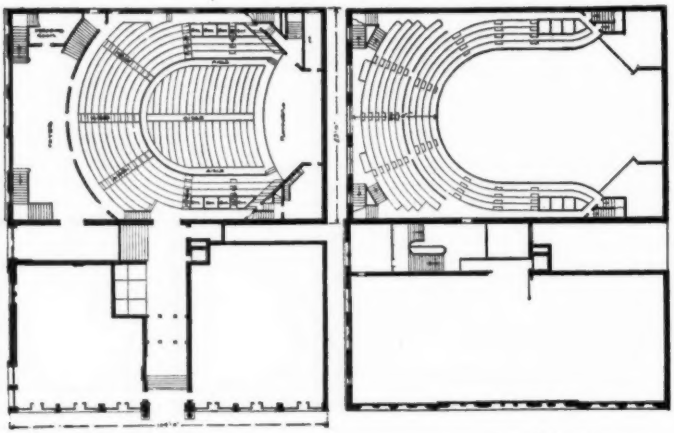
Large foyers and lobbies add greatly to the safety and comfort of an audience and may also be made valuable adjuncts to a comprehensive scheme of ventilation. In Europe the foyers, lobbies, and promenades often occupy much more space than the auditorium. American theater-owners and managers would do well to consider whether space given up to such purposes might not cause so great an increase in attendance at their houses as to yield good interest on the outlay for additional ground, building, equipment, and maintenance. A necessary sequence of adequate foyer and lobby would be better dressing-room and wardrobe accommodations than is ordinarily found in American theaters.

Experience teaches that Americans are always ready to make use of



CENTRAL MUSIC HALL, CHICAGO.
[Longitudinal Section.]

every opportunity given them for raising their standards of comfort and of luxury, and in their home life, their travels, and their public amusements, they justify Mr. Pullman's saying that "nothing is too good for the American people." The general introduction of great foyers, parlors, dressing-rooms, and wardrooms will tend to give theater attendance the character of a festive social function and may add to the box-office receipts the contributions of the participants in these functions, whose presence in gala attire will again be an attraction, for many who are not themselves "in the swim," but who delight in observing their more fortunate or more frivolous fellow-beings of the fashionable world. Then the foyer, as well as the stage, would interest and charm the audience and the intervals between the acts would be-



[Plan of Main Floor] [Plan of Balcony]

CENTRAL MUSIC-HALL, CHICAGO.

come as entertaining as the stage performance itself. And perhaps the street costume of the ladies and the high hat would yield to a drawing-room toilet and a less aggressive head-dress.

But this paper is already longer than was intended, and yet it has not exhausted its subject, or accomplished more than to skim over the surface of those of its phases which have been treated. Its chief purpose has been to call attention to the principal factors which enter into the design and construction of a good theater for an American city. It has been assumed that, from the owners and manager's standpoint, a theater is not necessarily simply a stage and auditorium built and maintained at a minimum of expense, for the purpose of packing within its walls a maximum number of people, but that stage

and auditorium should be designed and constructed with the one end in view, of attracting larger audiences by giving entertainments of the best possible character to people comfortably seated amid healthful, artistic and luxurious surroundings, and protected as far as possible against danger from fire, panic, drafts, or other causes.

From the point of view of the architect, the theater, as treated in this article, is not to be an opportunity for proving how unfit he is to build a theater by designing, in strict accordance with the tenets of any "style," a great proscenium, a grand entrance and staircase, of providing a ceiling surface for the development of a great allegorical painting, and leaving the rest to the stage-carpenter and a miscellaneous aggregation of engineers and "specialists," but that a theater is an organic whole, which in its totality and in its details must be conceived and built with but one purpose in view,—that of providing a stage upon which plays can be adequately presented, and an auditorium in which every person can in comfort hear and see all the stage presentations, in which access and egress to and from seats is commodious and safe, and from which actual danger from fire or panic has been practically eliminated. Whatever the architect knows of historic style and of plastic and pictorial art, should not endeavor to assert itself independently and in defiance of practical considerations and requirements, but should be coördinated and blended with these, so that the practical phases of the problem attain an artistic solution and that the work as a whole becomes a harmonious artistic creation from which all evidences and indications of the effort to harmonize apparently incongruous and conflicting requirements have been eliminated.

If architects and laymen who have read this article recognize that success in theater-building is not a matter of chance, and that the means for its attainment are not shrouded in mystery, but involve merely the application of the same mental processes which are the fundamental conditions of success in every undertaking, I shall feel amply rewarded for writing these pages, even if my readers think that, if what I have written is all which an alleged expert in theater-building can tell them about matters concerning which he and a few fellow adepts were supposed to possess exclusive knowledge, then any one who observes and thinks, and knows how to act under the guidance of close observation and clear and incisive thought, may join the ranks of those experts and be their equal or superior.

THE PRESENT CONDITION OF THE PANAMA CANAL.

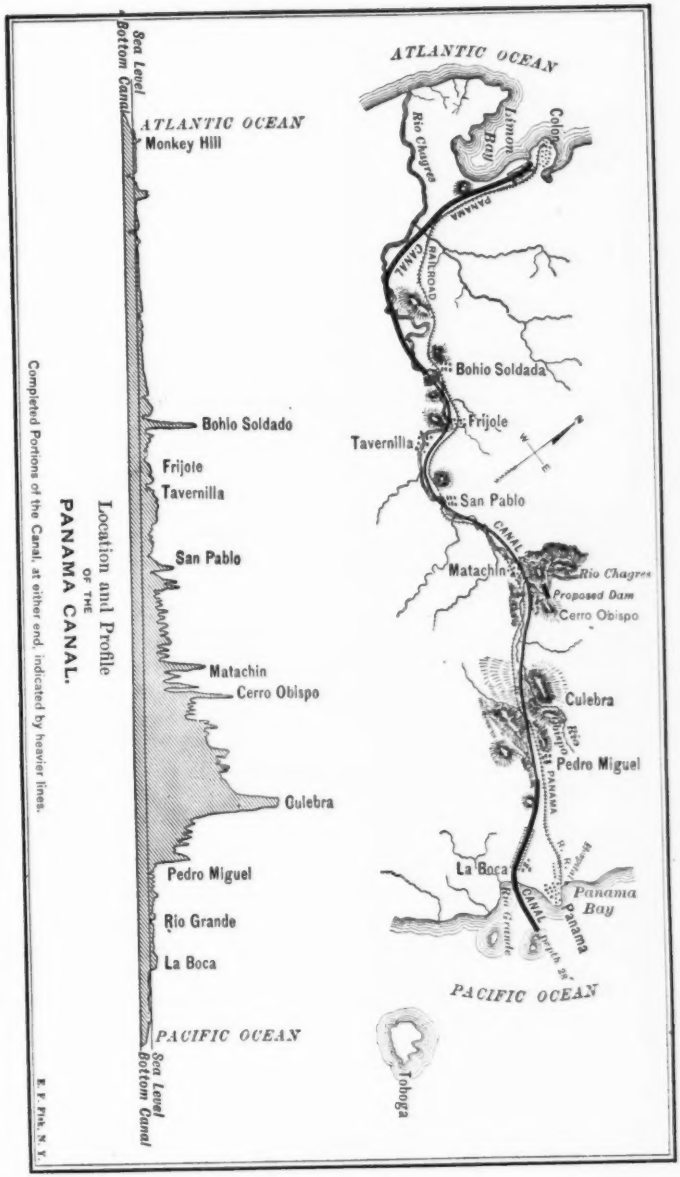
By Oscar A. F. Saabye.

THE Panama canal has been before the public so many years and has been written about so fully that the subject might seem to have lost all interest to magazine readers, especially since financial failure has been the result of the undertaking. But since serious efforts seem to be in progress for the reorganization of the construction company, with a view to completing the canal, there may be some reason for a practising civil engineer to offer a few facts respecting the present condition of the work already done, based upon recent personal observations.

It cannot be denied that the Panama canal, to-day, is practically a failure, financially considered, but this result has been reached through dishonesty, bad financial management, and worse engineering supervision. Hence this failure does not necessarily reflect upon the feasibility or practicability of the project as an engineering work, nor upon the selection of this route as a practical solution of the problem of a connection between the Atlantic and the Pacific oceans. If the Panama Canal Company, which is still in existence,—with the work already done, with its immense resources on hand, in form of machinery, buildings, dredges, barges, steamers, etc., for continued construction,—had sufficient funds to finish the work, under reorganized, good, honest management and competent engineering superintendence, the Panama canal would undoubtedly within the next decade prove to be not only the best adapted, but probably the most economical, solution of the long-standing question of a shipway from the Pacific to the Atlantic via the isthmus.

While returning recently from an engineering engagement in Ecuador, I was compelled to stop over in Panama eight or ten days to await steamer connection in order to reach the United States. Naturally, out of professional interest, I utilized this opportunity for an examination of the Panama canal, as it appears to-day, the result of which is this article. It may be remarked, however, that the figures used here are taken from the calculations of M. de Lesseps's engineers, and they are given for what they may be worth, as the time at my disposal did not permit any separate reliable calculations to be made.

As the canal has been surveyed and laid out between Colon, on the Atlantic, and Panama, on the Pacific side, it will have a total


Sea Level
Bottom Canal
ATLANTIC OCEAN
Monkey Hill
Bohio Soldado
Frijole
Tavernilla
San Pablo
Matachin
Cerro Obispo
Culebra
Pedro Miguel
Rio Grande
La Boca
PACIFIC OCEAN
Sea Level
Bottom Canal
Location and Profile
OF THE
PANAMA CANAL.
Completed Portions of the Canal, at either end, indicated by heavier lines.
E. F. Pub. N. Y.
ATLANTIC OCEAN
Rio Chagres
Limon Bay
Colon
PANAMA RAILROAD
CANAL
Bohio Soldada
Frijole
Tavernilla
San Pablo
CANAL
Matachin
Rio Chagres
Proposed Dam
Cerro Obispo
Culebra
Rio Obispo
Pedro Miguel
PANAMA R. R.
La Boca
Rio Grande
Panama Bay
CANAL
Panama
PACIFIC OCEAN
Toboga

length of 46.7 miles. Owing to the peculiar formation of Panama bay, the Pacific end is really the eastern terminus of the canal. The canal runs through the valley of the Rio Chagres and almost parallel to the Panama railway until within a few miles of Panama. Its distance from the railway varies from a few hundred feet to about half a mile. The proposed general width of the canal is 72 feet at the bottom and 100 feet at the water's level, with the exception of the section between San Pablo and Pedro Miguel, where the respective widths, as proposed, would be 78 feet bottom and 102 feet at the level of the water. The navigable depth is to be from 28 to 29 feet, and all curves of the canal to be constructed with a radius of not less than 8000 feet. At the mouth of the canal, at La Boca, about three miles southwest of Panama, it is proposed to build a basin, or kind of harbor, about 5000 feet long by about 400 feet wide, for vessels to await transport, and at Tavernilla, about midway between the Atlantic and Pacific, another to allow ships to pass each other.

The elevations along the canal route are about as follows: From Colon to Frijole, a distance of eighteen to twenty miles, the ground rises almost uniformly to 25 or 30 feet, with the exception of a short distance at Bohio Soldado, where the elevation reaches 160 to 170 feet above sea-level. Between Frijole and Matachin, about eleven miles distant, the elevations vary from 50 to 115 feet. At Matachin is another short *loma* (hill) of about 155 to 165 feet elevation. From Matachin to Culebra, a distance of about six miles, the elevations run from 90 to 260 feet, until they reach, at Culebra, the highest point on the whole route. Here the *cerro* is about 323 feet above sea-level for a distance of nearly 1000 feet. From Culebra the ground falls again uniformly to the Pacific, with an elevation of about 15 feet at the junction with the Rio Grande.

According to surveys and observations made by the engineers of the Panama railway, during its construction, the mean level of the Pacific is from .14 to .75 of a foot over that of the Atlantic. The highest tide at Panama is 21.30 feet; and the lowest 7.94; the highest spring tide in the Pacific over the highest spring tide of the Atlantic is 10.12 feet; the mean high tide of the Pacific over that of the Atlantic is 6.49 feet. These conditions would, if the canal is constructed as a tide-water connection, enable vessels to make the passage on one tide of six hours' duration.

The French engineers have calculated the total canal excavation necessary at something like 157,200,000 cubic yards, of which about 24,000,000 cubic yards are contained in the Culebra cut. This amount, I understand, includes also extra work outside the canal proper,—for instance, laterals for draining the Rio Chagres, etc. Of

this total excavation I judged that about from three-eighths to one-half—or about 70,000,000 cubic yards—has been done. Of the total length of the canal, about one-half, including about fifteen miles on the Atlantic side, has been finished or very nearly so, and there is water in this portion on both sides, its depth varying from 18 to 23 feet. The finished part is in comparatively good condition. Besides the work already done, the canal company has on hand, distributed at both terminals and at convenient points along the canal route, an immense stock of machinery, tools, dredges, barges, steamers, tugboats, and materials for continued construction. At Panama, La Boca, and Colon, as well as along the canal, are numerous buildings, large and small, for offices, workshops, storehouses, and warehouses, and for lodging and boarding the men who were employed on the work. The finished work, as well as all the machinery, tools, materials, buildings, etc., are well taken care of and looked after. The canal company employs 100 uniformed policemen, besides numerous watchmen, machinists, and others, whose sole duty consists in watching the canal and looking after needed repairs of plant and care of materials. In fact, the work and the whole plant is in such a condition, so far as I could ascertain, that renewed construction could be taken up and carried to a finish at any time it is desired to do so, after the company's finances will permit. In this connection it may be mentioned that the canal company has built, and still partly maintains, a hospital in Panama which in magnitude, comfort, equipments, and general appointments excels some of our best American hospitals, and, in fact, could give them good points in hospital management. This hospital, which is in charge of the French Order of Sisters of Mercy, is situated about 1½ miles north of Panama, on beautifully laid out grounds, at an elevation of 300 to 400 feet above sea level, giving a magnificent view of the superb bay at Panama and the surrounding country. It consists of sixty or seventy large, roomy, and airy buildings, and contains inside the grounds its own waterworks, drainage system, slaughter-houses, dairy, drugstores, etc., so that in case of any epidemic the hospital could be shut entirely out from communication with the low-lying city of Panama. Patients unable to pay are treated free in the same manner as those who are able to pay for their accommodations. At Colon there is a smaller hospital under similar management.

Now as to the feasibility of finishing the canal, and the difficulties to be overcome. The latter naturally resolve themselves into two classes, relating to the engineering and the financial features. As far as I could see, the engineering plans seem feasible and the obstacles such as might readily be surmounted. The chief difficulties encountered are: (1) The prevention of the Rio Chagres from overflooding its

banks during high waters and flooding the canal, and (2) the Culebra cut.

The Rio Chagres is a mountain stream, having its headwaters in the Andes, which the canal crosses at Culebra. Like all mountain streams, it is treacherous. In the dry season and under ordinary circumstances it discharges about 500 cubic feet of water per second. In the rainy part of the year, which lasts from six to eight months, during which time daily heavy rainstorms occur, the discharge of water per second rises to 20,000 cubic feet or more; it has even been known to reach the enormous quantity of 65,000 cubic feet per second, with a rise of the water to 45 feet above its normal level. The watershed drained by the Chagres, as far as it can influence the canal, is not very large or of much importance. The extreme high waters are caused by the heavy tropical rains. In order to protect the canal from such an enormous inflood of water from the river, which of course would soon destroy it and its usefulness, two plans have been proposed by the French engineers. The first one is to dam the Chagres at such a point as will retain the water, during rainstorms, long enough to permit the discharge to be controlled to its normal flow. The other is to change and enlarge the channels of the river, so that the water, during the high floods, will be discharged at a distance far enough away from the canal to secure its safety. Neither of these plans, so far as I understand, has been based upon accurate surveys or calculations. Upon a casual examination, the first one—damming the Chagres—seems to me the most feasible and probably the least costly.

After passing Matachin the river turns in an easterly direction, leaving the canal, and at Gamboa passes between two mountains,—Cerro Obispo and Cerro Santa Cruz. Here it is proposed to construct the dam, which would probably be about 5000 feet long and 150 to 160 feet high. An outlet of the water from the dam by a tunnel through Cerro Azul, to the left of Cerro Santa Cruz, is also proposed. The storage-capacity of the reservoir behind the dam is claimed by M. de Lesseps's engineers to be somewhat like 105,900,000,000 cubic feet. The cost of the dam is estimated at about $1,600,000. To build such a dam, with its tunnel-outlet and laterals, probably may at first seem an enormous undertaking. Its construction in point of engineering would, I fully believe, offer no insurmountable difficulties.

The Culebra cut is situated about nine miles from Panama. Its total length is about two miles, and the highest elevation, as already noted, is 323 feet above the sea-level. It has lately been proposed to tunnel through the highest portion. A French engineer has proposed recently to construct a lock on either side of the cut, so that it would only have to be excavated to a depth of 75 to 80 feet. This latter plan would undoubtedly save much time and labor and probably also

decrease the cost. But it would deprive the canal of one of the principal points in favor of its construction,—that of making it a tide-water connection. The cut would require about 24,000,000 cubic yards of excavation, of which the greater part is rock. Nearly all of the excavated stuff could be utilized in the construction of the dam across the Chagres. I do not see any great difficulty in taking out the whole cut, as originally proposed, aside from the time and labor it requires, and even that would be materially less than anticipated by the French engineers if the work were conducted properly and honestly. Some work has already been done in the cut, but none at the dam besides some preliminary examinations.

It has also been argued that the question of labor, as well as the unhealthful conditions on the isthmus, would prove a serious difficulty to overcome in finishing the canal. Undoubtedly the French, while they pursued the work, had much trouble in regard to laborers. The chief cause of this was that the French contractors picked up many of their laborers from the slums of all countries. These men were unaccustomed to this kind of work, and also to the climate. In many cases they did not desire work, but came out to the isthmus simply for the sake of adventure. Their past lives and environment made them an easy prey to disease and they consequently increased the death-rate, always heavy among the unacclimated in a tropical clime. If the work were to be taken up to-day, I believe that any number of native laborers could easily be had, if not from the isthmus itself, from the surrounding South and Central American republics, and from Jamaica, etc. These laborers, mostly negroes, are strong, healthy, and good-natured men, accustomed to work in the tropics. Their chief fault is laziness, but, properly managed, they would soon get over that and prove to be very efficient and cheap workmen. There has been no yellow fever on the isthmus for several years, but only sporadic cases of intermittent fever. As the work on the sections of the canal through the swamps and marshes has been finished, it is not supposed by the natives that any great amount of illness would be caused by the renewal of work on higher ground.

As to the financial question I must, as an engineer, hold aloof from saying anything about the probable cost of finishing the canal. It would simply be guesswork with the time at my disposal, and management by guesswork has already proved a costly feature in the history of the Panama canal. It should be remembered, however, in this connection, that although vast sums of money have been expended, and much of it uselessly, about half of the canal is finished, or very nearly so, and a large, valuable, and well-kept construction-plant, machinery, materials, and buildings, etc., are on the place ready for work. Before

the work is taken up anew it is an essential necessity that the present company should be thoroughly reorganized, under good and honest management. It is also absolutely necessary to have an accurate examination, survey, and estimate made, by competent engineers of the work already done and what remains to be done, as well as of the stock, machinery, and materials on hand, upon which to base future financial calculations.

The watchword of the new management should be efficiency and honesty. The French management was rather "a white elephant" upon the company's hands—more elaborate than useful. All the officers necessary on the isthmus would be a competent, honest chief engineer, with an equally competent engineering staff, and an efficient, honest general business manager.

In conclusion it may not be amiss to indulge in a few words of comparison between the Panama canal and Nicaragua canal, the latter of which also seems to be in sore distress just now. The supporters of the latter canal project claim chiefly, as to its superiority over the former, that it is more feasible as an engineering feature and cheaper to construct; that the healthfulness of the surrounding country is better than on the isthmus, and that better and cheaper labor can be obtained there. I have not personally been at Nicaragua, but I have seen the Panama canal as it is to day. At the latter place there is a full-equipped plant ready for renewed work, and there is already a railway running parallel to and within a short distance of the canal for all necessary transport. There is a splendid and accessible harbor at either terminus. All the buildings necessary for the work are there, as well as excellently-equipped hospitals ready for service. The canal is only forty-seven miles between oceans, and, if finished as proposed, as a tidewater connection, would allow vessels to pass through in about six hours. About half of it is finished. The remaining work, it is true, is heavy, but it is perfectly feasible and can be done.

Now at Nicaragua the inland connection between oceans, according to the surveys made, would be 170 miles long, of which there are 40.3 miles of new work to be constructed. The remainder is through the Rio San Juan and Lake Nicaragua, in both of which considerable work would also have to be done in order to make them safely navigable. There is no harbor of consequence at either terminus. The country is barren and without means of transportation for supplies. There is no construction-plant, and no buildings worth consideration. The difference of mean level between the two oceans is here greater than at Panama. The Nicaragua canal is to be constructed with locks, and the passage between oceans would be much longer.

USE OF COMPOUND STATIONARY ENGINES.

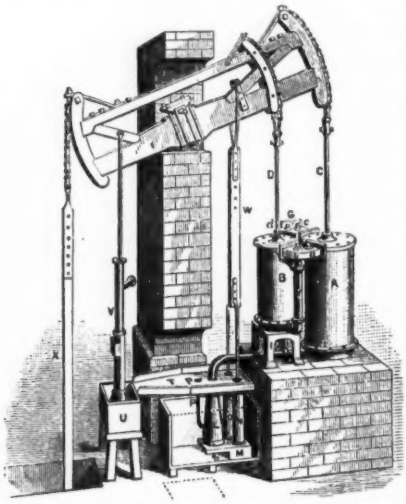
By Robert H. Thurston, LL.D.,

Director of Sibley College, Cornell University.

A "COMPOUND ENGINE" is one in which steam is worked in two cylinders successively,—*en cascade*, as the French express it, or in series, as the electrical engineer would say. The "high-pressure cylinder," taking its steam directly from the boiler and expanding it to a moderate degree, rejecting it at a still available pressure for further utilization, it is received into the "low-pressure cylinder" and, there expanding to a minimum terminal pressure, is finally exhausted into the condenser or into the air. The compound engine is of the class "multiple-cylinder engines," in which any number of cylinders may be thus worked in series, and in which this number is greater as pressures increase. Thus the compound engine usually is employed at pressures not far from 100 pounds per square inch; the "triple-expansion engine" (three cylinders *en cascade*) is adopted at 125 to 180 pounds, and the "quadruple-expansion" (with its four cylinders in series) at 200 pounds and over; expansion occurring, usually, to the extent of two or two-and-a-half times, and occasionally three or four, in each cylinder. The larger the number of cylinders, as a rule, the less the ratio of expansion adopted for either. The expansion commonly terminates at about five pounds pressure, by gage, in non-condensing engines, and six or eight pounds above a vacuum in condensing engines, in the best practice; the total ratio of expansion thus ranging from about five to ten in the former and between fifteen and thirty in the latter, for extremes of pressure.

The object of "compounding" is the reduction of the internal (thermal) wastes of the steam-engine, which constitute the most serious of the heat-losses in all modern forms of engine and amount to a considerable fraction—sometimes one-half, often one-quarter—of all the heat, steam, and fuel demanded by the machine. This now familiar waste, known to the engineer as "cylinder-condensation," occurs through the alternate heating and cooling of the cylinder-walls, as they are exposed first to the high temperature of the entering steam, and then to the cooling influence of the exhaust,—absorbing heat from the steam, storing it during the stroke of the piston, only to discharge it, unutilized, into the condenser or into the atmosphere. The greater the range of temperature and of pressure in the cylinder, the more serious this waste. The higher the initial pressure and the ratio

of total expansion, the more difficult it is, for this reason, to secure those economies which, in a purely thermodynamic operation, would follow the adoption of high pressures and corresponding expansion-ratios. In fact, so rapidly do these wastes increase with increasing expansion that, in the single cylinder, a point is reached at a very moderate ratio at which the gains are completely extinguished by more than equal exaggeration of "initial condensation" of the steam. Many an inventor has been disappointed and immense amounts of money have been lost in the vain endeavor to attain that economy in the operation of the engine by a "short cut-off" which its thermodynamic theory shows to be within reach if thermal wastes can be extinguished, and dynamic losses reduced to a minimum. Dividing the expansion among a number of cylinders in series, the range of temperature and the consequent waste is greatly diminished in each, —in fact, nearly in proportion, in well-designed engines, to the number of cylinders,— and the steam condensed in the first is reëvaporated at exit and supplies the demand for waste in the second, and thus through the series; the final result being the loss, in the whole machine, with its large ratio of expansion, of only the equivalent, substantially, of the waste of a single cylinder with its small expansion. Thus, were steam worked in a single engine, condensing at ten pounds terminal pressure, from an initial pressure of 150 pounds, the condensation, if the cylinder were unjacketed, would probably be not less than half of all the steam sent over from the boiler. In the compound engine, unjacketed, this would be reduced to something like 25 per cent., and in the triple-expansion and quadruple engines, respectively, to perhaps 20 and 15 per cent. With jacketed engines, these figures would be still further reduced. The low ratios of expan-

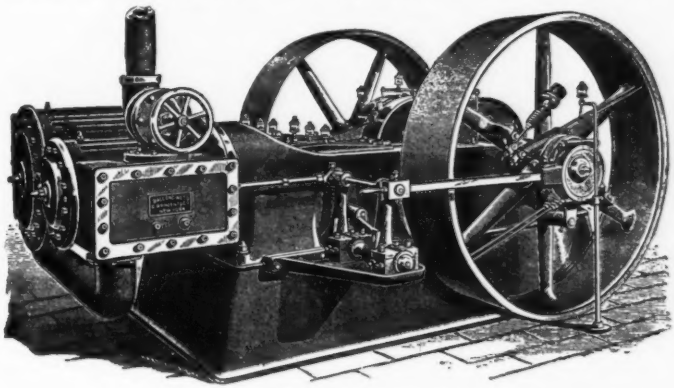


HORNBLOWER'S COMPOUND ENGINE, 1781.

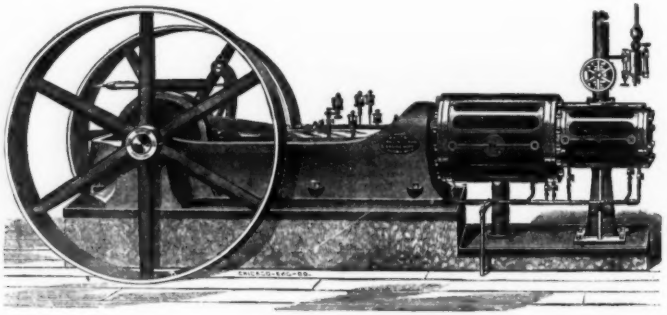
[*A*, the large or low-pressure cylinder; *B*, the small or high-pressure cylinder; *C* and *D* the piston rods; *X*, the pump-rod.]

sion in the cylinders and the cascade action thus enable the engineer to secure a gain which in most cases well repays the trouble, costs, and complication of the multiple-cylinder engine. There always comes a point, however, in this progress of costs with gains of economy, when the gain is more than compensated by the increased costs; and it often proves undesirable to use the most economical types. Cases are frequently met in which high economy cannot be afforded, as a matter of finance. These cases occur where fuel is cheap and engines are costly to build and to keep in repair, and where, as in passing from the triple to the quadruple machine, the gain by the change is comparatively small.

The compound engine, like many another invention, although only recently brought into common use and made successful, is a century old. It was, when first devised, in advance of the age and it failed, as do so many inventions, for that reason. James Watt is often said to have been the inventor of the steam-engine; he is called, with more reason, the author of all the minor details of the modern engine, and the compound engine is one of those modifications which, by his friends, is attributed to his genius. The fact is that the steam-engine of modern type is the invention of Newcomen, who was the first to introduce a train of mechanism in which the engine proper was set apart from the apparatus which it was constructed to drive. Watt gave to the engine of Newcomen the separate condenser, the first satisfactory forms of "self-acting" valve-gear, the governor, the steam-jacket, and other details, and applied it to turning a shaft as well as to the operation of pumps. The compound engine was first actually built and introduced in real work by Hornblower about 1781; but Watt secured a verdict



"CROSS" COMPOUND ENGINE.



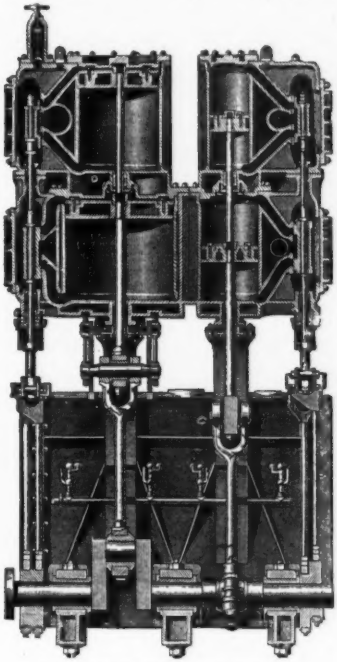
TANDEM COMPOUND ENGINE.

against him for infringement of earlier patents, and obtained an injunction which promptly stopped the construction of the new machine. In the course of this trial and in his communications to his friends on the subject, Watt claims the idea of compounding as his own and calls the machine his "double engine." Neither Watt nor Hornblower, however, seems to have really understood the theory of the engine, or its method of reduction of internal wastes of heat and steam, but thought it mainly useful in permitting larger expansion than was practicable in the simple engine with equable motion; variations of pressure on the piston, as expansion progresses, giving correspondingly irregular speed of piston and of fly-wheel, notwithstanding the weight of the latter.

During the controversy which arose at this time, Professor Robison enunciated a principle which has been since stated by Rankine, in almost the same words: "So far as the theoretical action of the steam on the piston is concerned, it is immaterial whether the expansion takes place in one cylinder or in two or more cylinders." The real advantages appear only when steam-pressures and ratios of expansion are comparatively great, and consist in an improved effect due to suppression, in large part, of cylinder condensation, and a more regular action than can be had with equal expansion in a single cylinder. Incidentally, also, it is possible to reduce the variation of stresses on the running parts of the engine by compounding.

The engine dropped out of sight for the time, but it was again brought out with higher steam-pressures, and made slow progress from the beginning of the century until about 1850, when the success of Randolph & Elder in marine-engine construction gave it a permanent place. It has since constantly gained upon the older type, its superiority constantly becoming more evident and marked as steam-pressures rise. In Watt's time, the engines of that great builder and engineer

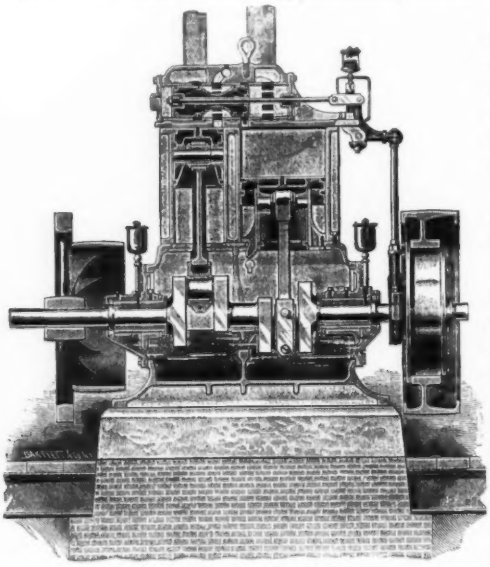
were found to be superior in economy to those of Hornblower. To-day the compound and higher types of multiple-cylinder engine often excel the rival simple engine in economy of steam by 25 to 30 per cent., and, in some cases, very much more ; while still further gain in fuel is secured in consequence of the smaller demand upon the boiler for steam and consequent improvement of efficiency in the latter.



QUADRUPLE-EXPANSION ENGINE.

The relative values of the several types of condensing engine at various ratios of expansion from a common initial high pressure are best exhibited by a diagram such as is given in the diagram. The lowest curve exhibits the varying efficiency of the simple, ideal, high-pressure engine, as measured in British thermal units or in pounds of steam per horse-power per hour, assuming 1000 thermal units expended per pound, no extra-thermodynamic wastes occurring. The next curve shows the costs, similarly measured, when friction, or the dynamic waste, is introduced ; the difference between the two being the cost of power required to overcome that friction. The highest full-line curve measures total costs in the same way, when heat-wastes are taken into the account ; the difference in magnitudes of ordinates of the second and the last curve being proportional to the expenditure compelled by those wastes. Midway between these last curves is shown another curve which, taking compounding as an expedient for substantially halving the internal wastes, shows the varying economy of the double-expansion engine. Still another curve divides the space measuring the cylinder-condensation loss by three, and exhibits the gain due to the use of three cylinders *en cascade ;* while still another curve, just below the latter, represents the action of the quadruple-expansion engine, in which the wastes are taken as one-fourth those of the simple machine, the dynamic wastes being taken as equal for all. Above each

curve is a dotted line which is obtained by superposing upon the total costs of the engine the proportional expenditures on account of interest, taxes, insurance, and other treasurer's accounts. The whole system is to be taken simply as illustrative, and as substantially right for the particular cases here considered. The method can be applied to any case in which the data can be secured, giving three or four points in either curve. But the data for the special case in hand should always, if possible, be obtained. Where this is impracticable, the engineer may often approximate the required curves and results by reference to familiar cases of approximately similar character.



SINGLE-ACTING COMPOUND ENGINE.

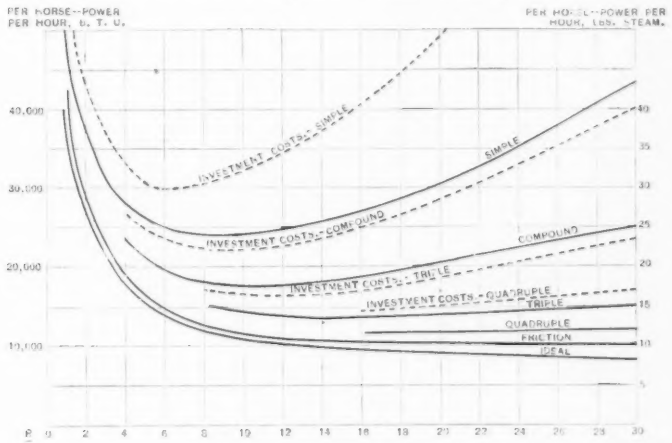
The striking and essential deductions to be drawn from such an investigation will be seen to be the following:

I. The expenditure of steam, in the ideal case, decreases constantly, with increasing expansion, without limit, in the case of the condensing engine with zero back-pressure, and up to the point at which the terminal pressure becomes coincident with the back-pressure in the non-condensing engine: ranging from about forty down to eight pounds of steam per horse-power per hour with from one to thirty expansions, in this case.

II. The friction wastes become an increasing tax upon the engine, with increasing ratios of expansion, and with consequent decrease of power obtained from the given machine. Ultimately, the engine would be unable to overcome its own friction, and it is at once obvious that, this waste alone being introduced, a point is somewhere passed at which costs reach a minimum, and beyond which expansion ceases to be advantageous.

III. Thermal wastes being added, to obtain the curve of efficiency for the simple engine, we find these wastes to be, also, an increasing tax and in rapid progression, giving a minimum ordinate at a very early point in the curve.

Expansion, in this case, instead of giving continual, unlimited gain, finds an early limit, and at a comparatively low efficiency, as measured by the heat, steam, and fuel consumed. For the simple engine of ordinary construction, this limit is often found at a ratio of two-and-a-half, or sometimes even less. This limitation of the maximum efficiency of the older form of engine by the occurrence of internal wastes is seen to be something extraordinary. In condensing engines, where, otherwise, the best ratio of expansion would be the quotient of initial



COMPARATIVE EFFICIENCY OF ENGINES.

by back pressure, the ideal engine would have a ratio of about fifty, in many cases, where about three would represent the limit, in wasteful engines, and five or six in the best ordinary work with unjacketed engines. The non-condensing engine, with 100 pounds gage-pressure would, in the ideal case, expand about seven times; while the real engine seldom has an effective expansion exceeding about four, and it is often as low as three.

IV. The multiple-cylinder engine adds to the cost of the engine, increases the external wastes, and the friction, other things equal, but divides the internal, and principal, extra-thermodynamic wastes in the proportion, roughly, of the number of cylinders in series. It gives, consequently, higher practicable ratios of expansion and enhances the

efficiency of the machine and its economy of heat, steam, and fuel, in the best contemporary stationary-engine practice, in something like the following proportion:

	POUNDS PER HORSE-POWER PER HOUR.	
	Steam.	Fuel.
Simple engine, best work, condensing, jacketed engine-cylinders	25	2.8
Compound engine, similarly designed	18	2.
Triple-expansion	14	1.5
Quadruple-expansion	12	1.25

The number of cylinders in series, in practice, is generally about one for each fifty or sixty pounds steam-pressure; the compound employing about 100 pounds, the triple-expansion, 150 or 160, and the quadruple coming in at about 200. The gain is thus due, in part, to increased pressure, as well as higher expansion; but the simple engine cannot take advantage of the higher pressures to increase the ratio of expansion in any approximation to that of the ideal case, as can the multiple-cylinder machine, because of the exaggeration of its internal wastes. Non-condensing engines, of either type, demand higher pressures than the condensing, in consequence of their high back-pressure.

V. The efficiency of the engine being known, together with its expenditure of steam, heat, and fuel, the choice of type is properly determined by the costs of construction, installation, and operation.

With coal at $1 per ton, for example, it is probable that the simple engine would be, on the whole, the cheapest type; and it is doubtful whether, in any such cases, the user could afford to pay for engines of higher economy; but with fuel at $5 a ton, the compound would be, on the whole, cheaper; with higher figures or at sea, where every pound of coal displaces a pound of paying freight and every ton a passenger, and where coal must be consumed to transport coal, the triple-expansion engine, and even the quadruple-engine, finds economical application. The reduced cost of the boiler-plant, in the multiple-engine system, comes in as an important element of economy of operation, not only as reducing interest accounts on first cost, but as lessening the repair-account, always large on boilers. This reduced expenditure on boilers often more than offsets the extra cost of engines, and makes the multiple-cylinder plant financially superior to the simple, where, otherwise, the latter would be wisely adopted.

A careful study of the finances of the case will show a curious series of compensations in this respect; the more wasteful engine having such superiority in its first-cost and interest accounts as to sometimes fully, and always in large part, compensate its deficiency on fuel account. These differences become still less when the whole financial problem is studied and the fuel account is thus made a

single item among many, in the comparison. On the whole, and under average ordinary conditions of operation, the compound engine is the most economical type. Where coal is very cheap, the simple engine is better; where fuel is very costly, the triple-expansion is best. The larger the amount of power demanded, the more can we afford to approach the ideal by refining the design and construction of engine, and by the adoption of the higher types. The more continuously the engine is worked, also, the more perfect can we afford to make it. In a flour-mill, running continuously night and day, the triple-expansion would usually pay handsomely; while in other establishments, working, say, eight hours a day, the compound would usually be best. Where an engine is attached to a single heavy tool, as often is the case in rolling-mills, or where, as on a yacht, it is in operation during a comparatively small portion of the working day, the simple engine with a hard-driven boiler, is best probably in all cases. But the saving in cost of fuel and reduced size and cost of boiler, taken together, may, in the rolling-mill be found to make the multiple-cylinder engine the more desirable. The fact is that the decision must depend, in every case, upon a financial study of the case in hand, and this should be made by an expert.*

Engines of the classes above indicated cost, ready for work, in ordinary times, $20, $30, $40, and $50 per horse-power at standard ratings, and their boilers, set and piped, about $18, $15, $13, and $12 per engine-horse-power, respectively; buildings and accessories cost about $12, $10, $9, and $8. The cost of the horse-power per annum at ten hours a day, and with coal at $5 per ton, exclusive of attendance, and inclusive of interest and repair accounts, ranges from $20 to $16, $12, and $10 for average cases, or about $1 per year, per pound of fuel used per horse-power for fuel alone, or a total of about $35, $33, $30, and $28. Coal at $2 per ton will reduce these figures about twenty-five per cent Costs or rents of buildings and other incidentals, may bring up the interest and other accounts in individual cases, and changing market rates of engines, boilers, fuel, and accessories may change the whole account in such manner as to lead to different final conclusions; but the principles involved and the usual conditions are fairly illustrated in the above discussion. Cheap coal and high prices of material and labor make the uneconomical engine best; opposite conditions make the more economical, but costly, engine desirable.

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*Dr. Charles E. Emery has made a number of interesting studies of this kind, for the latest and most complete of which see Transactions American Institute of Electrical Engineers, 1893, or Thurston's "Manual of the Steam-Engine," fifth edition, Vol. II, page 819. For a study of the principles involved, see "Manual," Vol. I, chapter VII. R. H. T.

Evidently those industries will be most benefited by the introduction of the multiple-cylinder engines which are most dependent upon the supply of power by means of the steam-engine as the prime motor, and those which are situated at points remote from the fuel-supplies and main lines of transportation, where, consequently, costs of fuel are excessive. Low costs of construction and high costs of coal, in combination, give highest value to the more perfect type of engine; but the locations are of limited area in which the gain by their use will not compensate for their extra cost. Those industries which continuously employ steam-power throughout the twenty-four hours can profit best by the highest types of multiple-cylinder engine; those in which, as in rolling-mills, the demand for power is very intermittent, will gain least, and may find the simple engine on the whole preferable. Thus a flour-mill at Minneapolis and a rolling-mill at Pittsburgh may each do best by adopting a practice exactly opposite that of the other. Those establishments requiring least power will profit least by the purchase of a compound engine. On the one hand, the gain in economy is greatest with smallest and cheapest engines; on the other hand, the value of the total saving of fuel is of less proportional consequence in the business, and first costs constitute a larger item in the proportion. The limit can only be determined for each case when every figure is available; but probably almost any ten-horse engine will pay for compounding under familiar conditions of the market and outside the areas of cheap fuel. The multiple-expansion engine, like every other engine, should be cared for by a good engineer who is also a skilled mechanic; but it does not necessarily demand more care or skill than the best simple machine, as, for example, a good Corliss or Greene engine.

Where power is very variable, to answer the requirements of an extremely variable load, the compound engine has usually the advantage of less loss of economy than the simple engine; although, where non-condensing and too large for its work, the wastes due to extreme expansion, beyond the point at which the terminal pressure on the expansion-line of the low-pressure cylinder falls below the back-pressure line, may sometimes prove so enormous as to make such proportions of compound engine vastly less economical than the simple engine properly proportioned for the same place. Within this limit the simple engine loses more than the other forms with extreme variations of load. Regulation, another essential point, may be made as perfect in the one as in the other; neither should vary more than 1 per cent. between no load and full load, and both should be steady, however sudden the change. In consequence of the gradual establishment of these facts and principles, the multiple-cylinder engine is

now rapidly displacing the simple engine throughout the world, and wherever economy of fuel is important.

Economy of fuel in the production of steam-power is a matter of far greater importance than is commonly realized, not simply as an element of finance, but also and mainly because of its bearing upon the welfare and comfort of the race. Civilization is to-day largely dependent upon steam-power, without which we must inevitably relapse into barbarism. The comfort of the most enlightened portion of the human race is dependent upon the use of fuel in temperate and cold climates, which means wherever civilization can flourish most completely and perfectly. But we have only a limited supply of fuel upon which to draw, and at the present rate of consumption we shall in a short time, as geologists reckon, entirely exhaust every known source of heat for power, and of warmth for the preservation of our families. The anthracite district of Pennsylvania, for example, is supplying to-day something like 50,000,000 tons of coal each year, and the bituminous mines over 100,000,000 tons. Adding to this rate only a moderate increase of demand, it is estimated that another century will see the whole anthracite deposit completely consumed. Our grandchildren and our great-grandchildren will be deprived of this essential element of comfort, if not of existence. The bituminous coal-fields are more extensive and will last longer; but Great Britain already sees approaching the end of her supremacy as a manufacturing country, and the continent of Europe will for a time take her markets, only, in turn, to be impoverished and destroyed in precisely the same manner. The United States must, in time, trace the same course, and the world, however great the as yet undiscovered or unmeasured deposits of coal and of oil which, in Asia, Africa, and other countries, remain untouched, must some time suffer from the complete exhaustion of all its supplies of fuel. The human race must then retreat to the tropics and retrograde into comparative barbarism unless other sources of heat and power can be found and utilized.* This ultimate and apparently inevitable fate can only be deferred, not averted; and the principal ameliorating condition must be the reduction of the quantity of fuel demanded by our heat-engines. This will occur to a moderate degree through the processes which have been above described; but it still seems likely that we must hope for some radical change in our methods of production and application of dynamic energy if we are to secure any very great modification of the period intervening between us and the time of Macaulay's New Zealander—who may prove to be the last of the race.

* Berthelot anticipates the ultimate employment of the interior heat of the earth by boring wells to depths of thousands of feet.

MAIN ENTRANCE, ANTWERP EXHIBITION.

THE INTERNATIONAL EXHIBITION AT ANTWERP.

By Edmund Mitchell.

WHEN the men of Chicago set about building their World's Fair City on the shores of Lake Michigan, they freely declared their intention, not only of surpassing all preceding efforts of the kind, but also of setting a standard that would never again be attained by any international exhibition to be held within the lifetime of the present generation. That the retrospective part of this bold program was more than amply fulfilled, the voice of public opinion in every country has allowed. That the prospective portion is quite likely of accomplishment, a visit to the Antwerp Exposition of 1894 will tend to make most men believe. The contrast, both as regards broad general effects and minor points of detail is a most remarkable one; and there can be no disputing the fact that the first of the World's Fair successors is running its course in the deep shadow of eclipse. It is not a mere question of magnitude; the land of the Liliputians was just as intensely interesting to Captain Gulliver as the land of the Brobdingnagians. At the same time, the very first glimpse of the Antwerp Exposition buildings shows how much of the charm of the White City was due to broad acres and to wide expanse of waters. At Antwerp there is no Peristyle, with vast inland sea shimmering in the sunshine beyond its classic columns; there are no lagoons, with swiftly darting electric launches and lazily progressing Venetian gondolas; there is no Wooded Island with log cabin and Hooden Temple peeping from out a wealth of flower and foliage. The exquisite landscape effects, which were possible only in a wide demesne, at Antwerp are wholly absent. The result has followed that architectural achievement has been hardly attempted. At Chicago, almost without exception, every building in the grounds was a thing of beauty by itself; and the general plan, which from the first had been kept fixedly in view, insured harmonious grouping, with the result that the scene as a whole was one of surpassing loveliness. At Antwerp, with everything "cribbed, cabined, and confined," there is simply a huddling together of shed-like structures, whose continuity alone helps to mask their ugliness. The central dome facing the main entrance is the only portion of the buildings where anything approaching to artistic effort has been made. As will be seen from the accompanying illustration, the result is not unsuccessful, although the palm

still rests, beyond doubt or cavil, with the beautifully designed and exquisitely proportioned Administration building at Chicago, which was not, as here, a mere façade, but had to stand the supreme test of isolation.

However, it may be granted that architectural effect is not the be-all and the end-all of an international exposition. In this respect Chicago soared to a flight which those responsible for succeeding undertakings of the kind may not consider themselves bound to emulate. An exhibition has to be judged on its merits as a thoroughly representative and well-arranged display of the products of the world and the handiwork of man in divers lands. Passing from the exterior to the interior of the Antwerp Exposition, and without any preconceived notion of lauding the United States at the expense of Belgium, I am at once struck with a second most glaring contrast between the two exhibitions. The magnificent system of classification which Chicago gave to the world has been lost sight of, and the old, effete geographical plan has been blindly followed. The result is that any one desiring to study a subject, or subjects, in which he may be specially interested is at the very outset hopelessly gravelled. Classification in the proper sense of the word there is none. There is no mining section, no transportation section, no electricity section; everything is jumbled together solely according to the country of production, so that a magnificent trophy of German ironwork is juxtaposed to a display of Japanese china, a butter-churn is next to a stand of French millinery, and agricultural products, or mineral ores have to be ferreted out in a score of odd corners. The only attempts made at grouping are with machinery for which a supply of motive power is necessary and with models of steamers from celebrated ship-building yards. It will be remembered that when the administration of the Chicago World's Fair adopted its system of classifying exhibits, there was a loud protest from more than one country against the proposal, on the ground that it would break up the exhibits and render impossible an effective display of the resources, industries, and wealth of any single nation. The Chicago directorate stood firm, and the contrast between their Fair and that now being held at Antwerp adds another proof, were such proof required, of the wisdom of their decision. At Chicago it was possible, with the minimum of inconvenience and the maximum of efficiency, to follow along each line of enterprise in every country of the world. Even the casual observer came away with a fairly full and coherent idea of wool-growing in many lands, of the lessons to be learned from competitors in dairying productions, of the utilization of machinery in a score of industries, of the mighty part played by transportation in the economy of modern life, and so on. At Antwerp

while the student of any special subject is beset with difficulties, the saunterer, although he may see many things of utility and many things of beauty, cannot possibly institute comparisons; he cannot grasp general principles, and confusion of mind is the only result. At Chicago, the youngest child who walked through the Electricity building had indelibly printed upon his brain an object-lesson of what the new practical science is accomplishing and is likely to accomplish in almost every department of human enterprise. At Antwerp, so scattered are the electrical exhibits, he will probably leave the buildings and have no idea whatever that such a power as electricity exists. If the administrators of the Chicago World's Fair had achieved no other result, they have this undoubted claim to honor, namely, that they have taught the art of classification at international exhibitions. The position of affairs at Antwerp drives home the lesson, and surely it will never again be forgotten in future undertakings of the kind.

After the great efforts put forth by almost every nationality at Chicago last year, it was naturally to be expected that signs of exhaustion should be manifested at Antwerp in 1894. The two countries that show this symptom in most marked degree are Great Britain and the United States themselves. Owing largely to the operation of the McKinley tariff, British manufacturing industries were not adequately represented even at the Chicago World's Fair. The colonies, however, came to the rescue of the mother country—New South Wales and Victoria with splendid wool trophies; the former dependency with pyramids of gold, silver, tin, and copper ores, arches of coal and building stone, and a fine collection of hard woods; Canada with cereals, minerals, and timbers; the Cape of Good Hope with diamonds, wool, mohair, and ostrich-feathers; India and Ceylon with striking pavilions filled to repletion with manifold products; even little Jamaica, Trinidad, and British Guiana, each with a varied and interesting display. In this way the deficiencies of England proper were covered up, and the part played by the British empire was an impressive and a creditable one. At Antwerp, however, the colonies are practically unrepresented, with the result that the British section is one of the poorest within the buildings. The explanation lies in the fact that there is a sharply-divided line of opinion in England as to the practical utility of the unceasing round of international exhibitions. It is the doubt as to an adequate *quid pro quo* that causes the leading manufacturers to hold aloof, added in some cases to a feeling of uneasiness as to whether it is not giving trade secrets away to show wares and processes to all and sundry. Quite a different cause has conduced to the inadequacy of the United States representation. America has,

alone among the nations, a building all to herself within the Antwerp Exposition grounds. Architecturally this edifice is a monstrosity; internally it is nothing short of being a ghastly failure, for there is not a single prominent line of manufacture or of production with which the name of the United States is associated all the world over that has exhibits to illustrate it. On two occasions when I entered the building the small number of visitors present were congregated round a woman of the "faker" class who was vociferously calling the praises of some new stone for sharpening knives, and disposing of the same at ten centimes per sample! To those who know anything about the resources of the United States, such a spectacle is merely ludicrous; but in the case of the ignorant—and the humble peasant folk who are flocking in great numbers to the Antwerp Exposition cannot be classed among the learned—inadequate representation becomes misrepresentation. No doubt the explanation of the fiasco lies in the fact that the manufacturers and producers of the United States made such a complete display at Chicago that they are content for a time to rest upon their laurels. If this, however, be the prevailing feeling in the country, it would have been better for the stars and stripes not to have been hoisted at Antwerp—not, at all events, over a special building which causes people to expect much and to experience a feeling of disappointment when they get so very little.

Africa, appropriately enough, holds a place of great prominence at the Antwerp Fair. Leopold III, king of the Belgians and titular monarch of the Congo Free State, has so identified himself with the opening up of the dark continent to civilization and to commerce, that no labor or expense has been spared to illustrate in his honor the work of African exploration and settlement. The village inhabited by some hundred and fifty natives from the Congo state is somewhat after the style of the Dahomey village in the Midway Plaisance, but it is on a larger scale, and, as the public is not allowed beyond the railing which encompasses the enclosure, the dark-skinned people are free to follow without interference their every-day avocations—grinding corn, weaving mats, working iron with the aid of a primitive bellows, and, in the case of the children, playing the simple games with which they are wont to amuse themselves in their far-away home. The picture is altogether a vivid and instructive one. But of infinitely greater importance is the vast technological exhibition which shows all the natural products of equatorial Africa, and also all manufactured articles which find a market among the natives. The latter section of the display is invaluable. It is a law of commerce that the manufacturer who would make his way in new countries must adapt himself to the prejudices or the caprices of his customers. Thus, in the Congo state

an ordinary hammer or a spade would not find a ready sale; but let its shape be adapted slightly to the primitive wooden implements in common use, and the article at once secures eager purchasers. Here at Antwerp every conceivable article, from cotton blankets to colored handkerchiefs, hatchets to tin tacks, coils of wire to strings of beads, of shape and color and material most acceptable to the negro in his own country, are shown. Moreover, the exact method of most suitably packing the goods for human porterage, and so saving the shipper the cost of breaking bulk, is illustrated. The exhibits are very complete, and are splendidly arranged; and manufacturers from Germany, France, Belgium, and Great Britain are giving to this department of the Antwerp Fair very close attention. Africa is further brought prominently before visitors to the exhibition by the diamond-washing machinery of the De Beers Mining Company, familiar to every one who entered the Mining building at Chicago; and by a crushing, amalgamating, and concentrating plant shown in actual operation by the leading mines of the Transvaal republic. The latter exhibit is supplemented by an admirably arranged collection of ores which, from the novelty and the complete success of the method of displaying, deserves a special word of mention. A long table runs the length of one of the Transvaal pavilions. On this table a map of the main reef is drawn, every individual mine being marked out. On each claim samples of the ore are placed, with cards conveying such information as the depth whence taken, the milling average per ton, etc. A duplicate key map hangs on the wall above the table, and by its aid the mining expert or the speculator interested in various properties can walk along the table and inspect the ores he desires to handle.

Another art, besides that of classification which the men of Illinois taught the world, but by which the Belgians have failed to profit, is that of "booming the Fair." The columns upon columns of gratuitous press notices in every country on the face of the globe which the department of publicity, by untiring zeal and industry, secured for the Chicago Exposition, afford a striking contrast to the meager and infrequent references to the Antwerp undertaking. Perhaps not 5 per cent. of the populations of London, Paris, or Berlin have even now ever so much as heard of the Belgian international gathering. Then again, there are no fête-days, no national celebrations, no frequently recurring ceremonial functions, all of which helped to keep the enthusiasm at Chicago from flagging for a single twenty-four hours. Here the people of the city and the country seem to regard their own Fair with complete apathy. When one recalls the heroic work of entertaining and showing the marvels of their land performed last year by Chicagoans and by citizens of the United States gener-

ally, the national character of the Belgian and of the American becomes sharply differentiated. The general lethargy seems even to extend itself to the side shows. Many old faces from the Midway Plaisance,—Moorish and Bedouin, Turkish, and Cairene,—are present at Antwerp; but there is none of the rollicking fun of the never-to-be-forgotten international street at Chicago. Continental folk take their pleasures economically; and the francs of 1894 are less plentiful than the dollars of 1893. *Hinc illæ lacrymæ!*

Perhaps, however, the most striking contrast of all between Chicago and Antwerp is outside the exhibition gates. The Fair of last year was held in one of the newest cities in the world; that of the present year is located in one of the oldest and most historically interesting. At Chicago the great sights were intensely modern—the lofty office-buildings, the stock-yards, the grain-elevators, the whale-back lake-steamers. At Antwerp we are in the city of Rubens, the city endeared to Thackeray and Lever, the city which was the scene of the bloody Spanish fury, of many a fight, of many a prolonged siege. The very name of the architect of the beautiful cathedral of Notre Dame has been lost away back in the centuries. Hard by is the Plantin-Moretus museum, a living picture of a famous Flemish printing-house at the latter end of the sixteenth century, with all the paraphernalia of book-production three hundred years ago preserved intact. The visitor has only to repair to Old Antwerp, which occupies a corner of the exposition grounds, to complete the illusion and find himself transported back to medieval times. Here, after wandering through the ancient streets, one may pause in the spacious market-place and listen to old-time music sung by choristers in the old-time garb of doublets, hose, ruffs, and flat-fluted caps, to an accompaniment played by such old-time instruments as clarionets, hautboys, wooden flutes, and side drums—music of the quaintest, for although the words may be inspired by hilarious delight over the advent of spring, or by rapturous admiration of the charms of the goddess of Love, the tune is invariably of such funereal gloom that the listener imagines he is hearing some penitential hymn. After all, Old Antwerp—the real old Antwerp, such of it as has been spared by the gnawing tooth of time, as well as this reproduction of life in "ye olden days"—may be allowed to purge the Exposition of its sins of commission and of omission. The traveler does not come here to ascertain the latest applications of electricity or the most recent improvements in locomotive engines. We did all that at Chicago.

THE MODERN MECHANICAL DRAWING-ROOM.

By Professor C. W. MacCord.

JUST as the manuscript must precede the printed page, so the making of adequate explanatory drawings is an essential preliminary to the execution of any mechanical project; the compositor cannot set up the book without "copy," nor can the artisan proceed without the guidance of working plans. The provision of at least reasonable facilities for preparing them is therefore an important element in the design of a machine-shop, or other engineering establishment, making any pretensions to completeness,—a fact which seems so perfectly obvious now as to cause wonder that it ever should have been overlooked or neglected.

Yet it has been, of which proof convincing, to the writer's mind at any rate, is furnished by the surroundings amid which he acquired his first experience in professional practice. Imagine a room with its floor some steps below the level of the sidewalk; a small and dusty room, ill-lighted by an abortive skylight, and two windows upon one side; worse ventilated by one door opening into an equally dismal office, and another communicating directly with the foundry, whence drifted in a dull and heavy air, laden with smoke and evil odors; ornamented with graceful festoons of cobwebs, thrice magnified by accumulated grime and soot. The side windows, facing the west, opened upon a narrow driveway, on the opposite side of which were a dirty boiler-room and a noisy engine; beneath these windows was a sloping shelf whereon were placed the boards at which the draughtsmen stood or sat, while before their eyes, not ten feet off, the busy carts went up and down, laden with coal or iron, from morning until night. This unattractive picture, far from being overdrawn, really serves to give but a faint idea of the drawing-office of a large and famous establishment in New York city, at a period by no means so remote as yet to have passed into ancient history.

Now it is not to be denied that in this world of ours men have risen superior to circumstances, and accomplished much good work under very disadvantageous conditions. But it has been in spite of, and not by reason of, those conditions; and the same men, in our opinion, would have done more, or done it better, or both, had they been provided with greater facilities. From which it may be inferred, and rightly, that we conceive the designer of the room just described to have been guilty of nearly all imaginable sins both of omission and

of commission; supposing that it was originally intended for the use to which it was actually put.

Clearly, the first requirement of the ideal drawing-office is light, and plenty of it. Moreover, the light should be as nearly uniform as possible, throughout the day. This is a very important consideration, to which we fear that due attention is not always given; and it obviously dictates that the windows in front of which the drawing-tables are placed should be neither on the east side nor the west: the weight of evidence, we believe, is in favor of a northern exposure. Should the room be in the upper story, there may be no objection to the use of a good skylight, of ground glass, for aiding in a diffused illumination: not, however, for a draughtsman to work by. Light coming from directly overhead, casts annoying shadows, and is most objectionable. The light should fall on the paper diagonally from the left; a good result will be attained by having the breadth of the window a little greater than the length of the drawing-board, and placing the latter, not centrally in front of the window, but somewhat to the right; some twenty inches from the wall, in order to give free access on occasion to the upper part of the board; and between the ends of adjacent boards a space of at least two feet should be allowed.

Having thus arranged a row of tables in front of the windows, a second row may be placed at a convenient distance back of them, the left-hand end of each being opposite the center of the one in front; and, supposing the windows to be of sufficient height, these also will be well lighted. For some of these a single long table may be substituted, should it be required, as in making plans of ships or bridges, or in laying out movements on a large scale.

Beyond this, however, it does not seem advisable to go, since experience shows that a third row if added would not, on very many days, receive an adequate amount of light. Thus, if a considerable number of men are to be employed, the scheme takes the form of a long and comparatively narrow room, with broad windows close together facing the north, and provided with two rows of tables placed *en échelon;* high, well ventilated, with a solid floor, and as free as may be from dust and noise.

It will greatly conduce to the neat and orderly appearance of the room if each draughtsman is provided with a locker, for the disposal of hats, overcoats, umbrellas, etc., as well as for the safe-keeping of T-squares and other instruments. These can be arranged in series along the side of the room opposite the windows, at the same time leaving ample space for chests of drawers or their equivalents for storing drawings, as well as for cases for spare drawing-boards.

At the eastern end of the room, next to the window, should be

placed a roll-top desk, and at its right a bookcase for works of reference. At the opposite end may be placed a chest of drawers containing paper, tracing-cloth, and other materials, as well as such instruments—protractors, beam compasses, etc.—as may be provided by the office for general use. At the left of this, that is in the northwestern corner of the room, a reasonable space should be set off for a lavatory, and enclosed by a partition reaching half-way to the ceiling. Within this, in addition to conveniences for ablution, should be a small case for the sponges, water-glasses, paste, etc., to be used for damp-stretching paper on occasion.

The dimensions of the drawing-tables and boards will naturally be determined by the nature of the work to be done, and their construction upon individual preferences. The writer's experience leads to the belief that, for general work in a machine-shop, the permanent table should be large enough to take a sheet of double elephant size, which is $27'' \times 40''$; the table should be considerably larger, not only to leave space for instruments, but because it is often desirable to make use of centers and points outside the limits of the paper; $32'' \times 54''$ has proved a very convenient size. No material is better than well-seasoned, straight-grained white pine, free from knots and turpentine; the thickness for the above dimensions should be $1\frac{1}{8}''$; the board may advantageously be lightened and also weakened transversely by planing in the lower side a series of grooves from end to end, a half-inch deep and three-quarters wide, leaving ribs of the same width between them; it should then be stiffened transversely by two hardwood battens snugly fitted into dove-tailed grooves, but not fastened, —thus leaving the board free to expand and contract as it will. If two or more pieces are required to make up the breadth, they should be simply matched and glued, not tongued and grooved; and, finally, no paint, oil, or varnish of any description must on any account be applied to either back or front. Such a board, supported by a substantial wooden frame of the "saw-buck" pattern, or by an iron one of lighter design, but in either case firmly and rigidly, forms a most satisfactory table; it should be provided with a drawer large enough to contain all the "case instruments" and minor appliances.

In addition to these permanent tables, there should be a sufficient number of portable drawing-boards; two very convenient sizes are $24'' \times 40''$, and $20'' \times 30''$; these are made in the same manner as the others, except that, instead of grooving the backs, it is enough to make a series of slits three-quarters of an inch apart, by running the boards lengthwise over a circular saw. These when not in use can be snugly stowed away in cases, being supported at each end by cleats, like the shelves in a bookcase. The front of the case must of course be

closed to exclude dust,—and preferably by a vertically-sliding flexible arrangement like the cover of a roll-top desk. A similar flexible apron, it may be suggested, might be advantageously adapted to a chest of drawers; for its use would permit the drawers to be made without fronts, which would greatly facilitate the handling of the contents, particularly if the latter consist of sheets nearly as large as the drawers. And this ought at least to be the case in regard to the office supply of drawing-paper. It is simply not possible for a draughtsman to work either well or rapidly unless his paper lies flat on the board, which a piece cut from a roll will not do, unless the "set" be taken out of it by damp-stretching; paper in the roll may be a trifle cheaper in first cost, but the loss of time will make it much dearer in the end; the work put upon it is of far greater value than the material itself, which should be procured in sheets, and *kept flat* in drawers of suitable size, so as to be ready for use on the instant.

Thus far nothing has been said of facilities for making blue-prints, which may be regarded as essential to the completeness of a drawing-office. But as an adjunct only, the production of drawings is quite distinct from their reproduction by any photographic process, and the light best adapted to the former is probably about the worst for the latter. It would seem that a printing-room constructed like a small observatory, standing by itself upon a flat roof, would be most advantageously situated; should this not be feasible, the choice in this latitude would fall upon a room whose windows face the south. Of these there should be two, and wide ones; a substantial platform with its top flush with the window-casing, outside of one of them, will afford facilities for the exposure of the smaller printing-frames. Through the other may project to a suitable distance a pair of iron ways, extending well within the room; upon these runs a truck carrying a turntable, to which are fixed two upright brackets, supporting the printing-frame by trunnions secured in the middle of each end; in this way the largest and heaviest frame may be manipulated with great ease. Within the printing-room should be constructed a small dark-room for preparing the paper—which has been found to be cheaper and more convenient than procuring it ready-made.

Blue-prints to be sent into the shop should be made upon comparatively thin paper; those of small size may be mounted by pasting them down either on smooth thin deal-boards or on heavy binder's board; larger ones might well be mounted on cloth, like maps, and stretched on light wooden frames: in either case they should receive when thoroughly dry a coat of clear shellac varnish. And the printing-room must be provided with the necessary conveniences for performing all these operations, which evidently could not be well done in the

main drawing-room, for many reasons, then, these rooms should be separated. In the present state of the photo-printing art, it seems that the process above alluded to is the one most available for the multiplication of working drawings. The reproductions are sharp, the operation is neat and rapid; but the effect of white lines and figures on a blue ground is very trying to the eyes, and it is sincerely to be hoped that in the near future this arrangement may be reversed. Two processes have come to the writer's notice, by which dark lines are produced on a nearly white ground; one, however, was by no means as convenient, and neither brought out the lines as sharply as blue-printing.

In the writer's mind there is no question that the most satisfactory course is to have all the drawings of every machine finished in ink upon paper of good quality; and these originals should not be permitted to leave the drawing-office. In working out details there is frequent occasion to compare one drawing with another,—in planning one part it is often necessary to refer to the drawings of several other parts already completed, in order to make sure that all the dimensions agree and that the harmony of design is preserved; again, since no human work is infallible, there is always a possibility that some discrepancy may be discovered, and a complete set of plans should be always at hand, so that any error may be traced to its source and the requisite alterations made. It is not, of course, absolutely necessary to ink in the originals, since tracings can be made from lines firmly pencilled; but the course suggested is on many accounts advisable. Whether it is adopted or not, however, it may be remarked in passing that it is well for every draughtsman to acquire the habit of pencilling in such a way that the whole or any part of a drawing can if necessary be traced without waiting for the inking process, which he can do with but moderate effort.

The custom obtains to a limited extent of having all drawings sent into the shop, or at least all those relating to any one machine, made upon sheets of uniform size. There is no doubt that this system has some practical advantages, especially in regard to the storing away of the plans, and the facility of finding any particular sheet when wanted. But it would seem that these advantages must ordinarily involve the expenditure of extra time and labor. Because in planning, it is not always possible to determine beforehand precisely how much room will be required; as the work progresses and the scheme is developed, some new idea may suggest itself, the perfect illustration of which requires more views, or takes up more space, than had at first been contemplated. Should the sheet thus prove to exceed the specified size, it would be necessary to make a new drawing upon a smaller scale;

and, in order to secure a pleasing uniformity of appearance, a reverse proceeding would be required should it turn out much too small.

Another, and a more common system, is to select a scale (which can usually be done without difficulty), such that the drawing of the particular piece in hand shall not exceed a certain maximum size, say that of a double elephant sheet, and, if it prove smaller, to cut down the paper so as to leave a reasonable margin. This system is more economical in the drawing-office and equally effective in the shop: and when it is adopted it will very often happen that the drawings of a given machine can be advantageously cut, if not to one uniform size, yet so that two or three different sizes will be sufficient for the whole set.

It is necessary to keep a catalogue, or book of record, in which is to be entered, as soon as completed, every original drawing which is to be preserved, with an indication of the place in which it is to be kept. Various systems of letters, numbers, and symbols have been devised with a view to ready reference, as well as to checking the delivery and the returning of duplicates. It is not within the scope of this paper to discuss the merits of these, much less to recommend the general adoption of any particular one; indeed, it is easy to see that a code which would answer admirably in one place, might prove to be wholly unsuitable in another. One thing, however, may be advised as of universal application,—which is, that every machine or engine should have a distinctive shop-name or number, and that, upon every drawing pertaining to it, this name or number should be prominently inscribed, followed, in less conspicuous characters, by a specific statement of the parts represented, and this in addition to any scheme of lettering or numbering.

Now, the object of working drawings is to show the workman what to make and how to make it, and this they must do both distinctly and unmistakably: and experience proves that drawings may be technically correct, and yet fail to accomplish this object,—they may lack the indescribable something upon which the *explanatory* quality depends. The most efficient and valuable man in the drawing-office is the one who, with the least expenditure of time and labor, can produce such work as will enable the construction to be carried forward with certainty and dispatch. For this purpose it is not sufficient that the drawings should be correct as studies of projection; they must be so selected and arranged as to be clearly and easily read. It is not possible to lay down any rule as to how many views of any piece shall be made, or what views they should be; this must often depend upon the nature of the case, and these points must be decided by good judgment and common sense, aided by experience. But the novice must

be cautioned against the idea that an end view, a side view and a top view are always needed and always sufficient. Just such and so many views must be made as will make the meaning clear beyond doubt; it must be kept in mind that a little time spent in the drawing-office is often saved many times over in the shop. Before sending out a sheet, let it be made certain that the drawings and annotations are such that, if followed, the workman can make what is wanted and cannot possibly make anything else: then, and then only, is the work complete.

Sometimes, especially if machines are to be manufactured by the quantity, with interchangeable parts, it is advisable to make a separate drawing of every individual piece. But this is not always necessary; for there must be drawings to show how these pieces are assembled, and the latter will in many cases answer both purposes. Take, for example, the connecting-rod of a steam-engine; a drawing which represents it as put together ready for use exhibits perfectly the construction of its component parts, and is even more explanatory than if the straps and brasses, gibs and keys, had been separated and scattered over the paper in isolated drawings. And the ability to *condense*—to reduce the number of drawings without sacrificing perspicuity—is a qualification of great value, ranking next, indeed, to the all-important one of determining the best views, and the best arrangement of them, in any given case. Both these powers are to a certain extent intuitive, but, like all others, may be increased by cultivation; and the subordinate, desirous of advancement, even if he have nothing else to do at first but to make tracings, will be able to learn much in these directions if he will but study the plans while engaged in that necessary drudgery.

Curiously enough, given a taste for mechanical pursuits, and some familiarity with mechanical details, these powers may be developed to a very high degree without any corresponding gain in ability to design. We have known more than one who, while competent to make from the rudest dimensioned sketches an accurate and perfect set of working drawings, could neither devise a new contrivance for any given purpose, nor determine the proportions of an old one. Notwithstanding these limitations, such an one may be found a most valuable assistant, particularly if his mathematical acquirements are such as to be serviceable in making computations of weights, centers of gravity, and the like, which are often necessary.

The *designing* of any engine or machine is a comprehensive term, including the devising of the mechanical movements, the determination of the general arrangement and magnitude, and the elaboration of the specific arrangement, as well as of the precise dimensions of the details. In regard to these there is great diversity of individual ca-

pacity ; thus one may be especially skilled in the geometry of motion and the construction of diagrams, another may be better able to select the one which should be adopted, and display greater fertility of resource and a sounder judgment in the neat and compact disposal of details, while neither might be as competent as another to determine the leading dimensions or proportions. The master of course is he who is equally at home in all, but they seem somehow to depend upon different qualities of mind—just as an excellent colonel might prove a bad general—and these qualities are rarely found combined and symmetrically developed in one and the same person.

The working out of details involves consideration, not only of the strength of materials, but of ease of access and repair, as well as of facility and cost of construction ; some knowledge of the operations in the shop, then, is an essential requisite. It is not necessary, however, that the draughtsman engaged upon such work should have "served his time" and become an expert mechanic. But in order to be thoroughly efficient, he should have had the opportunity to acquire both by practice and observation some familiarity with the manipulations in the pattern-shop, the foundry, and the fitting-shop. If he has had previously the advantages of a theoretical training in a technological school, so much the better, but whether he has or not, this practical schooling will subsequently benefit him in two ways: it will enable him to plan in such a way as to avoid needless expense and difficulty in construction, and, what is important, although sometimes overlooked, it will give him a positive apprehension of proportions. Having before him at once both the drawing and the thing drawn, he is compelled to grasp the relation between the two, and thus can thereafter judge more accurately of how his designs will look when executed.

On the principle that the greater includes the less, the head of the office should logically possess in a superior degree all the qualities and accomplishments of his assistants. This may be too much to expect—many a foreman has under him men more expert in special lines—but he should command their respect not only for technical skill, but for his education, personal character, and experience, particularly experience in the kind of work for which the shop is equipped. A "chief draughtsman," as that term is generally used, is in reality a constructing engineer ; and mechanical engineering is so subdivided that superlative excellence in all its branches is beyond human attainment. So, for instance, the chief in a locomotive-shop would not, ordinarily, be competent to fill a similar place in a shop devoted to heavy marine work, and *vice versa :* while neither might do well at the head of an establishment for building machine-tools, or one for doing electrical work. Naturally, the best work in a special line will be accomplished

in a shop devoted exclusively to it; but a more varied experience can be gained in shops where the work is of a miscellaneous nature, giving those who acquire it an advantage like that of an "all-around" mechanic over him whose skill is confined to the use of a single tool, as a planer or a lathe. The style of an author is influenced without his knowledge by the books he has read, and a wide range of reading is of benefit to him, no matter how original his ideas. And so the store of precedents thus laid up would be of advantage to the chief in a shop where new designs of new machines are in frequent demand; because in planning the mind is often unconsciously guided by analogy and by mental deductions from previous practice. But whatever his own qualifications may be, he must remember that the most successful generals have always been those who made the most judicious selection of their lieutenants; by studying the capacity and acquirements of his subordinates, dividing the work among them so that each shall have the task for which he is best fitted, and that in such a way as to let him understand that his value is appreciated, he will not only lighten his own labor, but, while securing greater efficiency, will more firmly establish himself in the esteem of his assistants and of his employers.

THE LAW GOVERNING STRIKES AND STRIKERS.

By Senator Cushman K. Davis and Judge Peter S. Grosscup.

NO recent period in the history of the United States has been more productive of brilliant declarations of the principles of free government, than that of the great railroad strike through which we have lately passed. Betwixt the Socialists and the Anarchists, the Bellamys and the Georges, the Populists and the whole brood of fiat-money fools, the atmosphere of civilized society is so charged with economic fallacies, and the public prints are so burdened with abuse of "trusts" and "corporations" and "capitalists"—practically every form of wealth, indeed—that it is small wonder the ignorant, the vicious, and the criminal elements of society regard themselves as the innocent victims of "rich men"; that labor leaders counsel and carry into effect measures which outrage the most obvious principles of liberty and equality; and finally, that every great strike is now simply the signal for riot, murder, arson, and anarchy.

We have, of course, had the usual flood of fine writing upon the subject, with no lack of effort at oratorical effects by the politicians and demagogues. But the feature of this period of labor disturbance, which broadly distinguishes it from previous ones, lies in the perfectly clear expositions of the law governing strikes which has been called forth, alike from the legislative, executive, and judicial branches of our government. Nothing in all judicial literature, for example, is finer, clearer, or stronger than Judge Grosscup's charge to the grand jury which indicted Debs and the other officials of the American Railway Union; nothing in the annals of free government is more inspiring than the impromptu, spirited, and patriotic deliverance of Senator Cushman K. Davis, of Minnesota, in reply to the seditious demand of the Populist Senator from Kansas (Peffer) that the government be given over to anarchy; and not since Lincoln's time have we had a grander example of statesmanship, or more signal evidence of the fitness for rule, than was shown in President Cleveland's masterful grasp of the opportunity to prove, once for all, that the Nation's army is here to enforce the Nation's law of liberty and protection to life and property.

Amid the mass of sensational matter recorded by the newspapers during the strike, the significance of these legal expositions was doubtless overlooked by many,—perhaps by some who may yet be called upon to face scenes similar to those enacted at Chicago. It is im-

portant, therefore, to distinguish the fact that these declarations were neither partisan manifestos issued to catch votes, nor moves to checkmate a rival in the game of politics. On the contrary, they were official declarations of the law under which we live. Back of every sentence were bayonets, and back of the bayonets was a Nation of aroused and enlightened freemen, bent upon the preservation of order and the defense of the inherent natural right to enjoy "life and liberty, *with the means of acquiring and possessing property*"—as was so pointedly stated in the first charter of American liberty, the Virginia Bill of Rights.

Now that the turmoil and excitement are past, and there is time for reflection, it seems both proper and important that people of intelligence generally, and the readers of this Magazine in particular—so many of whom are large employers of labor—should clearly comprehend the legal principles which governed the armed forces of law and order at Chicago and elsewhere, and which must be operative in future labor disturbances. We therefore reproduce here the essential portions of the official declarations which are deemed of most importance.—THE EDITOR.

IN the United States Senate on July 10, 1894, Mr. Peffer, the Populist Senator from Kansas, delivered his astounding speech in advocacy of his resolution presented the previous day, which demanded the purchase by the government of all railroads and coal-beds; the regulation of wages and hours of labor by law; the issue of all money by the national government exclusively; and finally, the collection of all public revenues by means of Henry George's single tax. The entire speech may be fairly described as an angry protest against all existing institutions and a defense of the riotous railway strikers in Chicago and elsewhere; and the climax was reached when he said:

"I wrote to a friend the other day that I was ready for the abolition of the Senate and would be willing to vote for it; and I would go still further and vote for the abolition of the House of Representatives; and I would favor that the personnel of the Government should be confined to a few men, not to exceed one from each State, and let them select a presiding officer from their own number."

It was in reply to this socialistic harangue that Senator Davis, of Minnesota, delivered the ringing speech which electrified the country and roused both the Senate and the whole people to a proper appreciation of the outrages that were being enacted at Chicago and elsewhere. The speech is far too long for reproduction here, but we give enough of it to clearly indicate the character of the whole. Said he:

"At a time when in the second city of the United States, and the fourth or fifth city in the civilized world, order is suspended, law is powerless, violence is supreme, life is in danger, and property is in the very arms of destruction, I am appalled to hear the trumpet of sedition blown in this Chamber to marshal the hosts of misrule to further devastation.

"This question does not now concern the issue between the Pullman Company and its employés. It has got beyond that. It does not concern the sympathetic strike of the American Railway Union. It has got beyond that. It does not concern any strike which may hereafter be ordered. It has gone far beyond that. A simple strike as to a local organization, not directly connected with the transportation instrumentalities of this country, grew into another strike of far more comprehensive proportions. That grew into a boycott. That boycott took the liberty of the American people by the throat, and then grew into a riot, and from thence into an insurrection which confronts this Government to-day with all the dormant and latent powers of revolution, and speaks here in the voice of its advocate, threatening and advising the dismemberment of the Government by the abolition of its executive and legislative departments.

"The Senator from Kansas speaks of the rights of labor, and in the abstract I am with him. No one denies that there are before the American people to be settled, in a lawful and constitutional manner through their legislative functions, vast questions of adjustment between the rights of labor and capital. No one denies that. It is the great problem of civilization all over the world. Man and machinery have been worked so into each other, through complex organizations of both, that sometimes it cannot be discerned where the man ends and the machinery begins. But in these times of present exigency and danger to government itself those are not the questions. The Senator from Kansas has not a single word of reproach for the blood that has been shed in Chicago in the last ten days, for the millions of property which has been destroyed. The red light of arson against the sky in that city has caused him no pang and elicited from him no word of disapprobation.

"People prate about liberty, and define that liberty as the liberty of *the particular class* they are speaking for. *The only liberty worth having in this country is the equal liberty of all men alike.* Liberty in its philosophical and common-sense definition consists in *that right of each individual to exercise the greatest freedom of action up to, and not beyond, that point when it impinges upon the like exercise of freedom of action of every other man.* Beyond that it is the destruction of the liberty of the weak by the strongest, a subversion of the very theory of a republic, and a return to primeval anarchy on the one hand, or, as an alternative, to despotism on the other.

"The Senator from South Dakota (Mr. Kyle) introduced into the Senate the other day a resolution, the substance of which is that no process, civil or criminal, shall issue from any court of the United

States in regard to acts affecting interstate commerce by the obstruction of trains, unless such acts involve the delay of the mails, and that the detaching of Pullman cars from any train shall not constitute an offense. At the time that resolution was introduced interstate commerce was arrested at Hammond, Ind., it was in collapse at Chicago, and freight, common passenger cars, and Pullman cars were being destroyed in that city. The meaning of that resolution is that, while these acts were flagrant and being committed, the United States was to be called upon to make itself an accessory to the crime while it was in the act of perpetration.

"Now consider the importance of the relations of this Government to interstate commerce. A clause in the Constitution, contrived by the wise foresight of our forefathers, has become efficacious and widespread in its operations a hundred years after it was framed. The railroads of this country, 176,000 miles in length, belting this land and laid over it like a network of iron, an armor of defense, are the daily convenience and the indispensable necessity of every man, woman, and child in the United States; and this movement is aimed at this great instrumentality, this great necessity, this indispensable convenience of our civilization, necessary to support life, to move troops, to move supplies, to carry on the Government itself. And by what acts? Tearing up the tracks, derailing locomotives, overturning cars across the tracks, burning them, robbing trains of provisions, disarranging switches,—all with the result of the loss of human life; and yet the resolution of the Senator from South Dakota proposes to take away from the United States courts the power to follow, repress, or punish these flagrant offenses against everything which goes to make up civilization and security.

"The sea, the great lakes, the rivers, everything within the admiralty jurisdiction of the United States, were once the main instrumentalities of commerce, and there is a stringent code of laws applicable to them and to the ship, as security for persons and passengers and the means of conveyance. I say here, without fear of successful or even attempted contradiction, that if any one of the acts which have been perpetrated in Chicago in the last ten days against persons and property of this great means and necessity of land communication, had been perpetrated upon the waters within the admiralty and maritime jurisdiction of the United States, those acts would have been piracy and punishable with death under the statutes of the United States.

"The authority of the United States cannot be denied. Within the limitations of the Constitution it is supreme. The duty of the President of the United States is to see that the laws are faithfully executed; the duty of the courts is to declare those laws and their consequences, and to execute them through their process. Is the interstate commerce of this country to be held in suspense and paralyzed, property destroyed, food cut off, conveniences taken away, necessity thwarted, until some remote disagreement as to wages be-

tween a private corporation and its employés can be adjusted? Is there any such reserved right as that to any of the citizens of the United States? Or is it the mere usurpation of a mob, commencing in riot and tending towards anarchy?

"Speaking of the people of the United States—a large, mouth-filling phrase that we have heard so often here—let us consider a moment that there are 5,000,000 farmers in the United States. Five million farmers and their families, constituting 45 per cent. of the population, are engaged in agricultural pursuits. I suppose that if anybody is entitled to be distinctively called 'the people,' the bone and sinew of this country, it is the farming population. *They supply the great cities. They represent the land; without them the country would be nothing.* They have been its invulnerable and loyal arm of defense in all times of peril. How are they affected by this strike of that segment of the people in Chicago? Have the farmers of this country called out to have commerce stopped until the question of wages can be settled between a few employés and a company constructing cars? Has any Illinois, or Minnesota, or Wisconsin, or Iowa farmer cried aloud for this remedy, and been ready to pledge his life, his fortune, and his sacred honor until the desired end can be brought about? Not one. How has it affected them? How does it affect the constituents of the Senator from South Dakota, or the constituents of the Senator from Kansas? They cannot market their wheat if this thing continues; they cannot market their wheat to-day. The early product of the farms of Illinois, the fruit, the early vegetables, have been rotting throughout the fields. The early fruitage of California has become a crop perfectly valueless under existing conditions. The beef of the country cannot be marketed in New York or Washington. It is rotting in Chicago,—and prices rise to the people. Mothers go from place to place in the city of Chicago seeking for milk for their children, and can scarcely find it. I say that no interest in this country is stricken such a deadly blow by this cruel, remorseless, unreasonable, merciless, and finally treasonable attack upon the liberty of the American people as the farming community of the United States; and they will find it out some day by the stern logic of events teaching them the lessons which I have endeavored to impart.

"The time will come in the new order of events when these matters will be satisfactorily arranged, for this Republic has always been adequate to every emergency, and these disturbing questions between capital and labor—they exist with strong equities in them, I admit—will be settled. I think that time is now upon us. But they will not be settled as the result of any such proceedings as those against which I speak to-day. Something more than capital, for which I care nothing; something more than the wages of the laboring man, for whom I care much; something more than a railway corporation, for whom I care nothing, is at stake here. National existence is at stake."

After a patriotic and stirring address of this character it is scarcely

necessary to add that the following resolution was passed by an overwhelming majority—thus finally and forever putting an end to the absurd idea that the national government is without supreme authority to regulate commerce between the States over the Nation's great highways, the railroads:

Resolved, That the Senate endorses the prompt and rigorous measures adopted by the President of the United States and the members of his Administration to repulse and repress by military force the interference of lawless men with the due process of the laws of the United States and with the transportation of the mails of the United States and with commerce among the States.

On the same day, and almost at the same hour that this stirring scene was enacted at Washington, another equally memorable event occurred at Chicago. A grand jury had been summoned before Judge Peter S. Grosscup, of the United States District Court, to pass upon the criminal responsibility of the leaders of the strike. It was an impressive occasion, a climax in the history of labor disturbances in the United States, and it was the judge's charge far more than the jury's subsequent finding that made it so. Said he:

"GENTLEMEN OF THE GRAND JURY: You have been summoned here to inquire whether any of the laws of the United States within this judicial district have been violated. You have come into an atmosphere and amid occurrences that may well cause reasonable men to question whether the Government and laws of the United States are yet supreme. Thanks to resolute manhood and to that enlightened intelligence which perceived the necessity of a vindication of law before any other adjustments are possible, the Government of the United States is still supreme.

"You doubtless feel, as I do, that the opportunities of life under present conditions are not entirely equal, and that changes are needed to forestall some of the dangerous tendencies of current industrial life. But neither the torch of the incendiary, nor the weapon of the insurrectionist, nor the inflamed tongue of him who incites to fire and sword, is the instrument to bring about reforms.

"To the mind of the American people, to the calm, dispassionate, sympathetic judgment of a race that is not afraid to face deep changes and responsibilities, there has as yet been no appeal. Men who appear as the champions of great changes must first submit them to discussion—discussion that reaches not simply the parties interested, but the wider circles of society, and must be patient as well as persevering until the public intelligence has been reached and a public judgment made up. An appeal to force before that hour is a crime not only against the government of existing laws, but against the cause itself, for what man of any intelligence supposes that any settlement will abide which is induced under the light of the torch or the shadow of an overpowering threat?

"With the questions behind present occurrences, therefore, we have, as ministers of the law and citizens of the republic, nothing to

do. The law as it is must first be vindicated before we turn aside to inquire how law or practice as it ought to be can be effectually brought about. Government by law is imperilled, and that issue is paramount.

"Now, the laws of the United States forbid, under penalty, any person from obstructing or retarding the passage of the mail, and make it the duty of the officers to arrest such offenders and bring them before the Court. If, therefore, it shall appear to you that any person or persons have wilfully obstructed or retarded the mails, and that their attempted arrest for such offense has been opposed by such a number of persons as would constitute a general uprising in that particular locality, and as threatens for the time being the civil and political authority, then the fact of an insurrection within the meaning of the law has been established, and he who by speech, writing, or other inducement assists in setting it on foot or carrying it along, or gives it aid or comfort, is guilty of a violation of law.

"The Constitution places the regulation of commerce between the several States and between the States and foreign nations within the keeping of the United States Government. Anything which is designed to be transported for commercial purposes from one State to another, and is actually in transit, and any passenger who is actually engaged in any such interstate commercial transaction, and any car or carriage actually transporting, or engaged in transporting, such passenger or thing, are the agencies and subject matter of interstate commerce, and any conspiracy in restraint of such trade or commerce is an offense against the United States. If it shall appear to you that any two or more persons corruptly or wrongfully agreed with each other that the trains carrying the mails and interstate commerce should be forcibly arrested, obstructed, and restrained, such would clearly constitute a conspiracy.

"If it shall appear to you that two or more persons corruptly or wrongfully agreed with each other that the employés of the several railroads carrying the mails and interstate commerce should quit, and that successors should, by threats, intimidation, or violence, be prevented from taking their places, such would constitute a conspiracy.

"I recognize however the right of labor to organize. Each man in America is a freeman, and so long as he does not interfere with the rights of others he has the right to do with that which is his what he pleases. In the highest sense a man's arm is his own, and, aside from contract relations, no one but himself can direct when it shall be raised to work or shall be dropped to rest.

"The individual option to work or to quit is the imperishable right of a freeman. But the raising or dropping of the arm is the result of a will that resides in the brain, and, much as we may desire that such wills should remain entirely independent, there is no mandate of law which prevents their association with others and response to a higher will. The individual may feel himself, alone, unequal to cope with the conditions that confront him, or unable to comprehend the myriad of considerations that ought to control his conduct. He is entitled to the

highest wage that the strategy of work or cessation from work may bring, and the limitations upon his intelligence and opportunities such that he does not choose to stand upon his own perception of strategic or other conditions.

"His right to choose a leader—one who observes, thinks, and wills for him; a brain skilled to observe his interest—is no greater pretension than that which is recognized in every other department of industry. So far, and within reasonable limits, associations of this character are not only not unlawful, but are, in my judgment, beneficial, when they do not restrain individual liberty and are under enlightened and conscientious leadership.

"But they are subject to the same laws as other associations. The leaders to whom are given the vast power of judging and acting for the members are simply, in that respect, their trustees; their conduct must be judged like that of other trustees by the extent of their lawful authority and the good faith with which they have executed it. No man in his individual right can lawfully demand and insist upon conduct by others which will lead to an injury to a third person's lawful rights. The railroads carrying the mails and interstate commerce have a right to the service of each of its employés until each lawfully chooses to quit, and any concerted action upon the part of others to demand or insist under any effective penalty or threat upon their quitting to the injury of the mail service or the prompt transportation of interstate commerce, is a conspiracy, unless such demand or insistence is pursuant of a lawful authority conferred upon them by the men themselves, and is made in good faith in the execution of such authority. The demand and insistence, under effective penalty or threat and injury to the transportation of the mails or interstate commerce being proven, the burden falls upon those making the demand or insistence to show lawful authority and good faith in its execution.

"Let me illustrate: Twelve carpenters are engaged in building a house. Aside from contract regulations, they each can quit at pleasure. A thirteenth and fourteenth man, strangers to them, by concerted threats of holding them up to public odium or private malice, induce them to quit and leave the house unfinished. The latter in no sense represent the former or their wishes, but are simply interlopers for mischief, and are guilty of conspiracy against the employer of the carpenters.

"But if upon a trial for such results they prove that instead of being strangers they are the trustees, agents, or leaders of the twelve, with full power to determine for them whether their wage is such that they ought to continue or quit, and that they have in good faith determined that question, they are not then, so far as the law goes, conspirators.

"But if it should further appear that the supposed authority was used, not in the interest of the twelve, but to further a personal ambition or malice of the two, it would no longer justify their conduct. Doing a thing under cloak of authority is not doing it with authority.

The injury of the two to the employer in such an instance would only be aggravated by their treachery to the associated twelve, and both employer and employés should with equal insistence ask for the visitation of the law.

"If it appears to you, therefore, applying the illustration to the occurrences that will be brought to your attention, that any two or more persons by concert insisted or demanded, under effective penalties and threats, upon men quitting their employment, to the obstruction of the mails or interstate commerce, you may inquire whether they did these acts as strangers to these men, or whether they did them under the guise of trustees or leaders of an association to which these men belonged.

"And if the latter appears, you may inquire whether their acts and conduct in that respect were in faithful and conscientious execution of their supposed authority or were simply a use of that authority as a guise to advance personal ambition or satisfy private malice.

"There is honest leadership among these, our laboring fellow citizens, and there is doubtless dishonest leadership. You should not brand any act of leadership as done dishonestly or in bad faith, unless it clearly so appears. But if it does so appear, if any person is shown to have betrayed the trust of these toiling men, and their acts fall within the definition of crime as I have given it to you, it is alike the interest, the pleasure, and the duty of every citizen to bring them to swift and heavy punishment.

"I wish again, in conclusion, to impress upon you the fact that the present emergency is to vindicate law. If no one has violated the law, under the rules I have laid down, it needs no vindication, but if there has been such violation there should be quick, prompt, and adequate indictment.

"I confess that the problems which are made the occasion or pretext for the present disturbances have not received the consideration they deserve. It is our duty as citizens to take them up, and, by candid and courageous discussion, ascertain what wrongs exist and what remedies can be applied. But neither the existence of such problems nor the neglect of the public hitherto to adequately consider them justifies the violation of law or the bringing on of general lawlessness.

"Let us first restore peace and punish the offenders of the law, and then the atmosphere will be clear to think over the claims of those who have real grievances. First vindicate the law. Until that is done no other questions are in order."

There is no hidden meaning here. It tells in language so simple that he who runs may read the dictum that from this date forward order must and will be preserved. This exposition of the law may indeed be regarded, not alone as the most explicit, but assuredly the most influential that our labor disturbances have yet called forth. Its influence has already been reflected in the decisions of other courts in various parts of the country, and notably by Judge Hopper of the County

Court of Passaic county, New Jersey, who on the 8th ultimo, in sentencing the men who resorted to Anarchistic methods to influence the strike of the silk-weavers at Paterson, said in part:

"Most, if not all, of the men engaged in these acts of violence were of foreign birth, and were either blindly ignorant or wilfully regardless of the rights and privileges of free American citizens. Every man in this free country has the constitutional right to work for any one who agrees to employ him, and to quit work whenever he chooses, and no one has the right to force him to do either. An employer has the right to engage men to work for him upon such terms and at such wages as they shall mutually agree and to discharge his employés or close his works whenever he may choose. Whoever undertakes to interfere with them by forcible means is guilty of a crime and should be summarily punished. Workingmen have the right to organize and form associations and by peaceable means endeavor to secure an increase of wages and otherwise improve their condition. But when they resort to force and destroy property or attack their fellow workmen to accomplish their ends they violate the fundamental principles of our free government and are not worthy to claim to be American citizens.

"The open or secret principles of anarchy or socialism, so called, upon which these violators of law claim to have acted never can and never should be allowed to gain a foothold in this free country. It is strange and unaccountable that workingmen will willingly submit to the tyranny exercised over them by Master Workmen, so called, often self-appointed leaders, who by their arbitrary orders compel men to quit work and with their families either suffer and starve or rely upon charity for subsistence. This has notably been the case in the late extraordinary scenes among laboring men in the west.

"By the mere *ipse dixit* of a self-constituted leader thousands of workmen have been compelled to strike out of mere sympathy with others, with whom they have no connection or interest whatever, and millions of dollars' worth of property have been destroyed. The timely action of the President of the United States has shown the utter futility and absurdity of such measures, and that the laws of the country will be enforced and the men guilty of such unlawful acts be brought to deserved punishment."

ELECTRICITY

Conducted by Franklin L. Pope.

REFERENCE was made in this Department about a year ago to the Wolff chemical process of treating sewage, by means of a liquid termed by its inventor "electrozone," obtained by the electrolytic treatment of sea-water, and to an electrochemical plant which had been installed near Brewster's, N. Y., for the purpose of purifying the water flowing into one of the streams of the Croton basin from which the city of New York derives its water-supply. This purifying plant having now been kept in continuous operation for over a year, it is possible to form some idea of the practical merits of the process. One very striking fact is that the mortality in New York city from diarrhœal diseases and from typhoid fever has fallen off perceptibly during the past year. For ten years prior to 1893 the average death-rates due to these two forms of disease were respectively 2.18 and 0.26, while for the year 1893, notwithstanding the increase of population, the rates have been only 1.75 and 0.20. A test made by Dr. E. A. Martin, chemist of the health department of New York city, proved that a sample of sewage containing 10,000,000 bacteria per cubic centimeter was rendered perfectly sterile by this process in 1 hour and 30 minutes. The electrozone is produced by converting the chlorids of the sea-water into hypochlorites and hypobromites by passing through it, between zinc and platinum electrodes, an electric current of 4 or 5 volts and several hundred amperes.

IN a recent number of the *Electrical Engineer* Mr. T. C. Martin gives an interesting and amply-illustrated account of the remarkable results which have attended the application of the Wolff process to the vast body of refuse from the city garbage-dumps which has been accumulated upon the shores of Riker's island, in the East river, not far from Port Morris. By midsummer of the present year, the aggregate amount of this refuse was estimated to be not less than 1,000,000 cubic yards. It covered an area of some 30 acres to a depth of 10 or 12 feet, and emitted the most nauseous stenches. An electrozone plant is installed upon a barge, capable of delivering about 4000 gallons per hour of the disinfecting liquid. The sea-water is first pumped into vats on board the barge, and subjected to the electrolytic process, and is then forced through several lines of hose, by means of which it is sprayed over the whole surface of the festering mass. The deodorizing effect, according to the personal investigations of Mr. Martin, has been little less than astonishing, and in this opinion he is supported by physicians and chemists of high standing. A permamanent plant is now in process of erection by which it is intended to treat the garbage as fast as it arrives on the island.

ELECTROZONE, it seems, is finding many other uses besides the one above alluded to. In all cases of suppuration and skin-diseases arising from micro-organisms, carbuncles, abscesses, and the like, its germ-destroying properties render it a most valuable means of treatment. It is also stated to have been applied with great success to the treatment of wood-pulp in the manufacture of paper. Thus, in a new field, electricity is once more proving itself to be one of the most universally useful, not to say indispensable, factors of modern civilization.

A RECENT journey through the interior of New England shows a condition of great activity among the local telephone-exchanges. A great number of these systems are being entirely rebuilt, with new and heavy poles, new wire, and improved

construction generally, while the number of trunk-lines between the principal business points is being largely increased. All this points to immediately increased facility of communication, and ultimately to lessened cost. Nothing is more probable than that the time will come when every house will have its telephone, as much as a matter of course as it now has its clock and its sewing-machine. The problem of lessening the cost of telephone-service so as to bring it within the reach of every person of moderate means, while apparently a very simple one, to the uninitiated, is in reality one of the most complex which has ever taxed the ingenuity of the American inventor. The initial cost of each apparatus and of its proportion of the connecting lines is not a very formidable matter, nor would the cost of use be at all prohibitory to small users if means could be devised to divide it pro-rata among them, in proportion to the use, but how to do this without entailing other heavy expenses is as yet by no means clear. The actual cost of providing exchange service, under the conditions which at present appear to be essential, is very great, and it is at present difficult to imagine how it can be materially reduced. Nevertheless, we venture to express the opinion that it will ultimately be done.

In a paper read before the Northwestern Electrical Association, Mr. A. D. Page contends that the only practical method of maintaining the average candle-power of electric lamps operated from a central station at a point which will be satisfactory to customers, or on a competitive basis with other modes of lighting, is to keep records of the average life of the lamps employed, where free renewals are furnished, and to remove and destroy all lamps which become dim, thus keeping the average life down to whatever constant has been determined upon as the most advantageous under local conditions. It is of course very poor economy for the customer who pays for his current on a meter basis, and buys his own lamps as he thinks he needs them, to continue the use of lamps when they are not giving more than 50 per cent. of their initial candle-power, but, as Mr. Page points out, an attempt to assure him that his lamps are giving but half the candle-power they should do, coupled with an offer to sell him new ones at 50 or 60 cents each, is not likely to remedy the difficulty. Some central stations are now selling lamps at actual cost, and at the same time endeavoring to convince their consumers that only by a liberal use of new lamps can they insure the maximum amount of light for a given expenditure. This is certainly the most rational plan of procedure, inasmuch as the profit on the sale of lamps is a very small matter compared with the sale of current and with the better quality of illumination furnished. This plan has the further advantage that, without dictating to its customers, a company may virtually control the kind of lamps which are used on its circuits. Mr. Page holds that at the present price of lamps, where fuel is high, it pays best to use high-economy lamps, destroying them at a point which shall insure satisfaction as to average light.

Professor G. D. Shepardson recently read a paper before a representative gathering of practical electrical men in which he made a forcible plea in behalf of technical education. He said that our technical schools are more and more insisting upon the fact that success in the engineering profession is only attainable by hard and unceasing work; that the student must seek to temper his theory with practice and govern his practice by theory. Students are now urged to spend their summer vacations in electrical factories, repair-shops, electric-light and -railway stations, in wiring, or in whatever way they may have an opportunity to gain experience in practical work. If circumstances are favorable, they are urged to continue their workshop experience through a full year before returning to finally complete their technical course. In many instances, after graduation, students have found permanent and remunerative employment in concerns with which they have spent their vacations.

Professor Shepardson also took occasion to point out what he regarded as the true relation between the technical schools and

the men who are engaged in the various electrical industries. The schools, he said, should aim to educate their pupils in such a way as to raise the general standard of construction and repair work; to assist in the development of new industries, and generally to be of service wherever located; they should offer the facilities of their libraries and laboratories for original investigation and research, and for expert determinations of efficiency, strength of materials, and the like. In return, those engaged in the electrical industries should encourage the schools by encouraging the graduates, and should make use of these institutions as employment bureaus. They may also in many instances greatly aid schools by sending to them samples and specimens, the results of peculiar accidents; exhibits from their scrap-heaps showing the effects of use or of abuse upon different materials and apparatus; pieces of discarded apparatus with reasons for disuse; specimens of historical interest, showing the process of evolution in machine design, etc. These all appear to be excellent suggestions, and, we have no doubt, will bear valuable fruit.

THE design and construction of small electric-lighting plants for isolated country mansions, factories, and the like has hitherto received less attention in America than in England, where installations of this character have become quite the fashion and furnish an agreeable and profitable field of employment for a considerable number of enterprising contractors. The *Electrical World* has published drawings and specifications of a plant adapted to supply fifty 16-candle-power incandescent lamps, which is operated by a 4 horse-power gas-engine. The dynamo is wound for a potential of 135 volts, and is employed to charge a storage-battery of 53 cells. The normal rate of charge and discharge of the cells is 12 amperes, and the battery has a maximum capacity of 140 ampere-hours. When fully charged, it will supply forty 16 candle-power lamps for four hours. The weight of each cell, including the solution, is about 65 pounds. An automatic switch is used, which is so constructed that whenever the electromotive force of the battery exceeds that of the dynamo, the circuit is held open, but under the reverse conditions it is instantly closed. Obviously, in places where gas is not available, the automatic petroleum engine, which is now to be had in great perfection, would serve the same purpose. In fact, it would seem as if, with a good automatic engine, the costly and troublesome storage-battery might safely be dispensed with altogether, in a plant of this kind. It is a field well worth the attention of our electrical inventors and manufacturers.

A GREAT deal of unavailing ingenuity has been expended by amateur inventors in past years, in the effort to produce an effective repeater for long-distance telephone work. We are pleased to learn, from a letter published in the *Electrical World*, that a substantial advance has been made in the direction of the long-sought-for goal. This correspondent writes that after a great many experiments he finally succeeded in producing an instrument of which it could truthfully be said that "it was just as easy to carry on a conversation over a long line with the instrument in circuit as without it." We advise the writer to rest content with this triumph; it is not likely to be soon surpassed, either by himself or any one else.

THE question of submarine-cable communication between the Dominion of Canada and the Australian and New Zealand colonies by way of the Pacific ocean received serious consideration at the recent Intercolonial conference at Ottawa. Mr. Alexander Siemens presented facts and figures intended to demonstrate the feasibility of the project, both technically and commercially. The line recommended by him is in four sections, extending from Vancouver, British Columbia, to Ahaipapa Bay, New Zealand, touching at three intermediate islands, and having a total length of 7340 nautical miles. The total estimated cost of the enterprise is £2,000,000, while the annual cost of maintenance and oper-

ation is put at about £120,000. Mr. Siemens thinks that if the company met with average success, it might be expected to earn say £30 per mile per annum, which is less than the average earnings of all the submarine companies since 1887. In this case the annual income would be £220,000 per annum. According to the statement of Sir John Pender, the cable traffic to the Australian colonies by the existing lines is worth £209,628 net per annum. One of the existing Atlantic companies is said to earn an average of £50 per mile per year. The laying of a Pacific cable is of course only a question of time, and it is also probably only a question of time when it will prove fairly remunerative.

MR. H. WARD LEONARD, who has devoted a good deal of attention to the problem of the industrial applications of electrical heating, has recently made an improvement in apparatus for this purpose, which consists in giving the resisting conductor a thin coat of fireproof insulation and then casting a body of metal around it. Although the insulating material is necessarily a poor conductor of heat, yet by reason of its thinness it offers but little resistance to the transfer of heat to the metal. Mr. Leonard considers that where the cost of energy per horse-power per annum does not exceed that of two tons of good coal, electric heating can now compete, on the score of economy alone, with fuel burned in the ordinary manner. Of course there are a large number of special applications of electric heat in which the condition of comparative economy has but little weight, in comparison with convenience and utility.

IN a paper read before the Northwestern Electrical Association, Mr. B. J. Arnold gave some interesting figures showing the economy of operation of fifteen large direct-current electric central stations in different parts of the United States. The average cost per ton of coal was $2.28; watt-hours produced per pound of coal, 81.5; cost of coal per kilowatt-hour, $0.0146; cost of other expenses per kilowatt-hour, $0.0465, and total cost per kilowatt-hour of current delivered to the consumer, $0.0620. A large American alternating station having an output of 2,090,000 watt-hours per day, pays $3 per ton for coal, and, running 9½ hours per day, produces 52 watt-hours per pound of coal, at a cost of coal per kilowatt-hour, $0.0289, —almost twice as much as the average of the fifteen direct-current stations. The alternating station at Cologne, Germany, shows 71 watt-hours per pound of coal. This discrepancy, however, is in part to be accounted for by the much greater average distance to which the current is transmitted by the alternating system.

Mr. Arnold expresses the opinion that while Europeans have recognized the advantages attending the use of storage-batteries as auxiliaries in central-station work, we in America have been slow to see this advantage. There is of late, however, a tendency apparent among American engineers and station-managers to look with more favor upon this adjunct, and, as there are many instances in which a battery plant as an auxiliary can be made to pay handsomely, it is probable that within the next five years we shall see many such plants installed.

ONE of the electric cars of the North Hudson County railroad of New Jersey, has been experimentally equipped with a small auxiliary storage-battery which is charged from the main line, and is automatically switched into connection with the car-lamps whenever the main current is interrupted,—as by detaching the trolley from the wire,—but is disconnected from the lamps when the main current is restored. It would seem that a device of this sort, if not too costly, might often be of considerable service.

THE power-house for supplying electricity to operate the Baltimore Belt tunnel will be a brick and stone building having an area of 69×300 feet. The capacity of the dynamo and engine equipment will be 12,000 horse-power. Work on the building has already commenced and it will be pushed to completion as rapidly as possible. The trains of the Baltimore

and Ohio railroad are to be hauled through the tunnel, steam-locomotives and all, by huge electric motors.

THE record of serious accidents and deaths to passengers in electric street-cars, arising from collisions and derailments, is becoming a somewhat alarming one. Half a dozen such casualties were reported in the list for June, published in the *Railroad Gazette*. The frequent determination of the managers and exploiters of street-railway lines to cross steam-railway tracks at grade in large towns, in which they are too often abetted by the local municipal authorities and even by the courts, is the real cause of most of these accidents, but it will probably be necessary to slaughter a great many innocent persons before anything effectual will be done about it.

AN electric railway for both passenger and freight traffic is now in successful operation between the towns of Wilmerding and McKeesport, in western Pennsylvania. The line is about four miles in length and passes over a mountain 1200 feet high, encountering some grades as steep as 12 per cent. with many sharp curves. Each car is equipped with two 30-horse-power motors. A conveniently-situated coal-mine made it possible to locate the power-house and car-barn midway on the line, on a plateau at the top of the mountain, and a picnic ground has also been established near by, which is expected to become a place of pleasure-resort for the citizens of both towns, and thereby add largely to the revenues of the road. The water used in the boilers is pumped from the foot of the mountain by an electric motor.

THE Illinois Central railroad is experimenting with an electrical apparatus for killing grass and weeds. A flat-car carries a dynamo-plant and a sort of brush consisting of a fringe of copper wires depending from its front end, which is made long enough to cover the width of the track and extend to the end of the ties. A pressure of 10,000 volts, produced by a step-up converter, was found to be sufficient to do the work effectively, Steam and brine have both been heretofore tried for the purpose, but with less satisfactory results than those which have attended the use of electricity.

A PROJECT is under consideration for supplying San Francisco with electric power brought from Clear lake, a distance of about 75 miles, at which point it is stated that it is possible to render available about 30,000 horse-power. It is estimated that by employing a pressure of 25,000 volts, about 20,000 electrical horse-power may be delivered in San Francisco. The estimated cost of the hydraulic plant is $1,000,000 and that of the electric plant, $3,000,000. Owing to the high price of fuel, energy is worth about $10 per horse-power per month in that city. San Francisco, with its 300,000 inhabitants, in spite of being thus handicapped by the high price of fuel, has become the ninth manufacturing city in the Union. It now uses about 60,000 horse-power. If the Niagara undertaking turns out successfully it is probable that no time will be lost in putting the California project under construction. Apparently the only critical point is as to the practicability of employing so high a pressure as 25,000 volts, and this is likely to be settled affirmatively at an early day.

THE little town of Union, Mo., has a system comprising 250 16-candle-power commercial electric lamps, and 16 32-candle-power street lamps, which are supplied from an alternating station at Washington, ten miles distant. By means of raising and reducing converters, the transmission is effected over a pair of No. 8 copper wires at a pressure of 4000 volts. There are many other places in the country where this plan apparently might be carried out with great advantage.

IT may be worth while to note that a simple tangent galvanometer, which will give the value of an electric current directly in ampere readings, may be made by employing a coil of five convolutions of wire, which should be of a thickness not

less than No. 8 American gage. The mean radius of the coil must be 6.72 inches for New York and Chicago; 6.37 inches for Philadelphia, and for any other place the coil must have a radius inversely proportional to the intensity of the horizontal component of the earth's magnetic force at that place. When traversed by one ampere of current, such a coil will deflect a magnetic needle exactly 45°, and hence the tangents of all the angles must correspond directly to the number of amperes flowing in the circuit.

WE would suggest to the managers of some of our electrical journals that, while the publication of immense scratchy "illustrations" which cover pages of valuable space and fail to illustrate anything beyond the bad taste of their designer, may be open to justifiable criticism, the case is not much better when photo-engravings of complicated machines, and still worse, of graphic diagrams containing mechanical curves, are so severely "ensmalled" that the reference letters and explanatory legends cannot be made out, even with the aid of a reading-glass. We trust this intimation may be sufficient to ensure a reform in this particular.

THE *Electrical Engineer* publishes an illustrated description of what it terms "the smallest electric railway in the world." This outfit has been built for the delectation of a youth of seven summers at Bellwood, Minn., who is his own general manager and motorman. The track is 600 feet long and 14 inches gage, and is equipped with a motor-car and two trailers. The engine is a 2 horse-power petroleum motor, and the power-house is provided with a complete equipment of station instruments. This is a characteristic example of the way Young America is sometimes taught to do things.

FOR two years past the Cœur d'Alene Mining Co. of Idaho have been operating the pumps and air-compressors of the Poorman mine by electricity, and the results show a saving of $100 per day in the item of fuel alone over the steam-machinery formerly used. The power-house is situated 1½ miles from the mine, the generators being operated by Pelton water-wheels under 800 feet head. The concentrator and compressor are each driven by a 175 kilowatt motor, while a 150 kilowatt motor serves to operate the mine pump, raising 500 gallons of water per minute to a height of 500 feet. One great advantage attending the use of electric power is stated to be the avoidance of the destructive effects of steam on the timbering of the shafts.

A POWER BUILDING designed for the occupancy of 64 different small manufacturing concerns is under construction at Pittsburgh, Pa., in which no belting, shafting, or pulleys will be used. A complete system of electric motors will be installed on each floor, the power for which will be supplied by a 250 horse-power steam-driven electric generator located in the basement.

THE telephone line connecting the city of Vancouver, B. C., with the waterworks dam is carried across the mouth of the harbor, a distance of 1200 feet, in an insulated cable inside the water-pipe. Owing to the immense force of the ebbing and flowing tide, no independent cable could be made to last more than a few weeks. The present plan has proved to be entirely satisfactory.

ARCHITECTURE

Conducted by Barr Ferree.

WHILE architects in America are devoting their bodies and souls to the study of French architecture, especially in its Renaissance phases, architects in England are giving unusual attention to the study of English monuments. The tendency of American architectural thought is such that contemporary British work is almost entirely unappreciated in America, which bids fair, almost, to become more French than France. An important and interesting indication of the renewed study of English monuments by Englishmen is the number of works on English architecture that have recently appeared in England. The most important of these is undoubtedly the splendid work of Mr. Gotch, "Architecture of the Renaissance in England." A less pretentious work, not by an architect, and intended to reach the general public, or the employers of the architects, as its author constantly remarks, is Mr. Loftie's "Inigo Jones and Christopher Wren."* Though addressed to the public at large, the architect will find much to interest him in the book. It is pleasantly written by an accomplished writer, who displays very considerable earnestness in his work, who seeks to establish more than he can accomplish, and who has failed to produce an elaborated or even satisfactory study of the work of the two notable architects whose names give title to his book. As a sketch of the rise and decline of modern architecture in England the work is fairly satisfactory, but of his eight chapters only one is devoted to Jones and but two to Wren, the remaining portions being devoted to the state of architecture in England before Jones and to the successors of Wren. In a measure the subject demanded this treatment. The work of Jones and of Wren, while entirely distinct in itself, marked an epoch in the general history of English architecture. Standing alone and apart as both did, in a certain sense, they were still products of causes, rather than distinctive men who, by the mere force of their genius, impressed a new style upon England. Wren, indeed, left English architecture in a state totally transformed from that in which he found it, but it was already moving in the direction in which he worked, though had it not been for the splendor of his genius and the force of his individuality the evolution of the Renaissance style in England would unquestionably have been conducted on much more laborious lines than was actually the case. In thus clearing the atmosphere of English architectural art in the thorough and effective manner that his vast genius enabled him to do, Wren performed a task of the utmost value. The architectural tendency of the fifteenth and sixteenth centuries on the continent was toward that new form we call the Renaissance. It is immaterial whether Gothic architecture had died a natural death or not, or whether it was capable of further development along lines that have never been tried. It is a fact that men were moving away from it, and though England was, in this, as in all other architectural styles, a good century behind the continent, it had the very great advantage of possessing in Wren a master spirit who was able to effect a sharp transition without any especially painful intermission.

Apart from the great service Wren did to England in emphasizing the changed conditions of architecture, his most notable work was the change he effected in church architecture. Not many years ago a great deal was heard in America about the "modern" cathedral, and Wren's great

* *Inigo Jones and Wren, or the Rise and Decline of Modern Architecture in England.* By W. J. Loftie. London and New York ▸ 1893.

cathedral church of St. Paul was held up as the final expression of the modern church idea. In a certain sense this is true. The huge open space under the dome of St. Paul's appears, at first sight, admirably adapted for a preaching service, in contradistinction to a liturgic service for which the Gothic cathedrals were especially planned and adopted. But in order to demonstrate successfully that a church planned like St. Paul's is typically modern—the only type, in fact, to be followed in a modern church building—it is necessary to show, first, that the liturgic service is a thing of the past, and, secondly, that a church so planned is entirely satisfactory for a preaching service. As a matter of fact, neither of these propositions can be shown to be true. If we take the church of England, for whose service St. Paul's was nominally constructed (though Mr. Loftie shows that Wren was forced to keep in mind its possible reversion to the Roman Catholic faith) it must be at once admitted that the liturgic service shows no sign of decay,—a point well emphasized in St. Paul's itself by the erection of a large and costly *reredos* within the last few years. And every one who has been privileged to attend a service at the cathedral is fully aware that it is one of the most difficult churches in the world in which to hear, and that it is impossible to hear the voice of the preacher save from points very near the pulpit. It would seem, therefore, that no reason at all exists for taking St. Paul's as a type for "modern" churches. It is true there are now many non-liturgic denominations, and many churches in which the sermon is still, and perhaps always will be, the most important part of the service. For such denominations an amphitheatrical church is doubtless better suited than the older forms of the Gothic. But until it can be shown that such a service is the only genuinely modern one, the idea of St. Paul's as the typical modern church must be given up. The history of the religious development of the present century has certainly not been such as to give foundation for any such belief. It is *a* modern type of church building, it must be granted, but certainly not *the* type. The question is scarcely raised in this form in Mr. Loftie's interesting volume, but it is suggested by the current applications given to Wren's plan.

THE Home Insurance building has now been exhibited on lower Broadway, New York, for a sufficient length of time to enable the inhabitants of that city and its numerous visitors to become thoroughly accustomed to it. Like many other recent buildings, it has its good and bad points. Its architects deserve credit for not having attempted too much, and for embodying in their façade several excellent ideas which, while very good in themselves, have not been carried out in the happiest manner. In the first place, they started out with the intention of dividing the façade into three well-defined portions,—a base, a superstructure, and a top. This they have done, despite the fact that the openings in the base have no relation to those of the superstructure. They deserve some credit also, for giving this lower portion some ornamental character. They have not put all their ornament at the top, where it is practically invisible, but have used it in the lower portion, where it may be seen. The detail itself is too small, and in too low relief, to have sufficient value, but the idea of its distribution is a good one. The central portion is further to be commended for its severity. In a fifteen-story building it is the worst possible thing to spread the ornament all over it, though such a system is not strange in New York. But the architects of this building have been brave enough to boldly recognize this fact and their design gains measurably by it. Unfortunately, the vertical lines of the building are repressed to their utmost limit. Throughout the whole front there is no line extending through more than two stories, and in the superstructure where they would most naturally occur there are none at all. In fact, every effort has been made to emphasize the horizontal lines by carrying string-courses across the front over and below the windows and in emphasizing the window sills. It is true enough that the force of these lines is somewhat weakened by their slight projec-

tion, and the uniform white surface of the building, but they are unmistakably present, and a most valuable element in a vertical design is lost. The upper portion is scarcely as happy in treatment as the lower. The *loggia* at the top gives some relief, but is scarcely happy in its effect. There is no proper cornice to the building, either in connection with the *loggia* or above it, and this feature is forced to act in that capacity, a work to which it is scarcely adequate. The detail here is also wanting in relief and is almost lost. The gabled roof is an ingenious idea, though there is no reason at all for bringing a high narrow building to a point at the top, and the silhouette is far from good. Yet there is a great deal of satisfaction in the brilliant red tiles with which this wedge is covered. Looking at the building from the steps of the elevated railroad at the Bridge entrance, one sees the most patriotic building in New York. The dazzling whiteness of the walls, and the scarcely less brilliant red of the roof, forms, with the bright sky that often hangs over New York, a glorious monument to the national colors of our country. And it is more appropriate from the close proximity to the City Hall, over which the flags of foreign nations seem to float oftener than the flag of the United States. It is a patriotic object-lesson of no small value, and derives a special interest from having being taught by architects with well-known leanings towards Tammany Hall. The patriotism of that noble body was never more thoroughly or appropriately illustrated than in this building.

AMONG the most atrocious buildings in New York (and it is now necessary to visit the metropolis to see what very bad things can be done in architecture,—it used to be necessary to go to Philadelphia) the Downing building takes easy precedence. The erection of monstrosities is proceeding at so rapid a rate in New York that doubtless it will not long retain its preëminence in this respect, but meanwhile it affords food for ample and thoughtful study. The Downing building is fourteen stories high and is apparently constructed entirely of iron. It should, therefore, afford the utmost delight to those constructional purists who maintain that the construction must, at all hazards, appear in the exterior. Unfortunately the material is only apparently shown here, for while the building is supported by a steel cage, the front of it was filled in with brick work, and an alleged cast-iron decoration (?) or surfacing placed over it. The building is intended for offices and manufacturing purposes and the front is composed almost wholly of windows. It is true that there is a narrow metal line on either side of the front, and two others dividing the façade into three equal portions, running clear to the top, though interrupted at every floor. But these are lines only, with scarcely width enough to give them structural value, and entirely worthless from the standpoint of design. The great height of the building renders it easily one of the most conspicuous in the lower part of New York, thus emphasizing the utter contempt its owners have manifested for architectural art. No other recent building of this size in New York has been carried out with so open a disregard of architectural proprieties. Even the commercialism of the building is unnecessarily emphasized, while the cast-iron surfacing with which it is covered is a reversion to a style of design that every one must have long since hoped forgotten. That it should have been revived in this year of grace, and that any one could be found who would use it for a business investment, is very sad indeed, and shows very clearly that even in circles closely allied to architecture there is amplest room for the greatest improvement. We notice with some astonishment that this building is advertised in the daily press of New York as the "handsomest business building" in New York. With it is coupled that miracle of horrors, the Bennett building, which would be the worst cast-iron building in the world were it not for the Downing structure. There must, therefore, live somewhere in the metropolis a soul to whom these amazing vagaries in cast-iron are the furtherest expression of architectural art. As we have no objection to giving a friendly hint, even to those

from whom we differ, we would suggest that he could doubtless obtain a handsome honorarium from some enterprising dime-museum manager. Ten cents would certainly be a very small sum to pay to see any one who could say in public that the art of these two buildings was good and pleasing in his eyes.

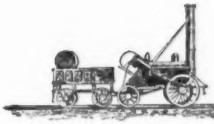
HERE they are: Mr. John P. Benson, Mr. Albert L. Brockway, Mr. William B. Bigelow, Mr. Charles L. Berg, Mr. William A. Boring (first Frenchite, president), Mr. John M. Carrère, Mr. George Cary, Mr. Pearce Casey, Mr. Walter B. Chambers (secretary), Mr. Walter Cook, Mr. Randolph Coolidge, Mr. Ernest Flagg, Mr. A. D. F. Hamlin (adjunct professor), Mr. Henry S. Hunnewell, Mr. Richard M. Hunt, Mr. Richard H. Hunt (corresponding secretary), Mr. Thomas Hastings, Mr. Abner T. Haydel, Mr. John G. Howard, Mr. Edward Howe, Mr. E. L. Masqueray, Mr. Joseph H. McGuire, Mr. Charles F. McKim (vice-president), Mr. Grenville T. Snelling (instructor), Mr. John Stewardson, Mr. Edgar V. Seeler (assistant professor), Mr. S. B. T. Trowbridge, Mr. Alfred Thorp, Mr. Edward L. Tilton, Mr. Whitney Warren.

These gentlemen are the practising architects who are members of the Society of Beaux-Arts Architects, New York. They are the only real and genuine Frenchites in America. With one conspicuous exception they are all guaranteed to supply designs in the latest Paris fashion. Any one changing his abode for a more fashionably-designed residence is cordially invited to lose no time in conferring with some one of them. Business is, perhaps, not so plentiful now as it might be, and, while no reduction can be made on account of slackness of trade, very special inducements can be offered in the latest importations from Paris. Absolutely genuine Parisian designs, made by their makers in Paris itself can be had in most instances if bespoken early. It will be noticed that while all the American schools of architecture are more or less under French influence, no full professor is a member of the Society, though three assistant professors are among the members. It should also be added that the list of students who have studied in Paris, but who were not regularly entered at the École des Beaux-Arts, is quite considerable and is not included in the above list. Neither are a number of draughtsmen who have not yet hung out their shingles as architects included. The Society does not yet number all the École men in America, but its membership includes the great majority of those who may be properly termed Frenchites.

THERE is no more important question before the architectural profession (except, possibly, that of education) than the formation of architectural partnerships. How shall they be constituted, and what shall be their basis? These are momentous questions, and on them many an architect has wrecked his life, and many more will do it in the future. On the face of it there would seem to be an advantage in the division of labor. Under some circumstances—under many circumstances—two heads are better than one. The duties of the modern architect are so varied and complex that on general grounds a division of labor is not only desirable but absolutely necessary. But how shall it be divided? The obvious answer, a constructive member and a designing member, is far from working easy in practice. The relative functions of each are easier set down on paper than adjusted in actual practice. It will be the easiest thing in the world for the designing member to propose artistic expedients that the constructionist will pronounce impractical, unnecessary, absurd, unthinkable. On the other hand, it is quite as possible for the soul of the constructionist to be fired with artistic zeal, manifesting itself in the creation of imagined artistic devices, that the artist partner will at once recognize as only describable in the language that has, as likely as not, just been used towards himself. Nor is the case simplified when two designers form a partnership, unless the class of work be divided absolutely at the outset. In this case no conflict of opinion need be expected. But unless some such division

is made the differences of opinion that may arise between two designers may become too large to be contained within the cubic area of the mutual office. And this may not only become large but acute, and it is not every nature, much less delicately artistic ones, that can stand the strain long enough to permit each man to mutually adjust himself to the limitations, peculiarities, and abilities of the other. The basis of all architectural copartnerships is mutual confidence. A radical division of construction and design, or of classes of structures, is of no value unless there goes with it a large supply of mutual confidence, that is available on all occasions, that is never wanting in strength and honesty, and that can absolutely be depended on. The question is not so much what each man can do, but how far each is willing to trust the other, and how long.

VISITORS to the World's Columbian Exposition will remember the very handsome exhibit in the English section of Messrs. Hampton & Sons, whose reduced model of the Banqueting Hall at Hatfield House attracted a great deal of deserved attention. We are indebted to this firm for their book of "Designs for Furniture and Decorations for Complete House Furnishing," which is one of the most costly and splendid trade publications we have seen. Illustrated with collotype reproductions of interiors, with colored plates of rugs, hangings, china, and other household fixtures, and with nearly 2000 photographic reproductions of furniture, it forms a most useful and convenient handbook to contemporary British furniture. Dealing, as it does, with every article of domestic use, it necessarily includes many subjects that can scarcely be admitted within the realm of the artistic; but the book is extremely interesting. Many of the designs shown are of real excellence and originality and the whole may be most profitably studied. A work like this, which deals with all sorts of furniture, is intensely suggestive of the multiform requirements of modern domestic life. Every year, almost every day, is marked by the addition of new articles of furniture, sometimes useful, sometimes ornamental, but generally characterized by an artistic feeling that is eloquent testimony to the prevailing note of the artistic in current life. It is true this is very far from being well expressed in many instances, and very costly houses are even to-day fitted up in a gorgeous manner quite incompatible with the canons of good taste. But these instances are becoming rarer and rarer every day. The modern decorator is constantly extending his practice, and the best architects are rapidly creating a permanent demand for his work. Furniture is one of the easiest things in which to sin artistically,—not so much because it is cheap, but because the furniture and decoration of one style is easily replaced by that of another. Probably no people have more frequently sinned in this respect than the Americans, but we know of no people that can faultlessly declaim against them. The rapid increase of wealth in America has, of course, hastened any development of this tendency that might have become manifested. It is, perhaps, difficult to escape from such consequences, but opportunities of doing so are becoming less rare every day. At all events it is a distinct mark of progress when the shoddy is thrust out by the artistic; the reverse process may be witnessed only in periods of deep degradation.



RAILWAYS

Conducted by Thomas L. Greene.

ON the first of July a few more defaults in bond interest were made, complicating in some cases the existing conditions and in others adding to the already long list of railways which have confessed themselves bankrupt. More than one-quarter of the railway mileage of the United States is now operated by the courts and an equal proportion of our entire railway capital is thus discredited. "Bradstreet's" reports the percentage of commercial failures at less than 1 per cent. of the number of merchants and corporations in business. While, of course, we cannot compare the statistics of so large a corporation as a railway with the statistics of failures among trades-people large and small, yet it is manifest that so great a disproportion should have the most careful consideration at the hands of those who are hoping for a return of prosperity. The prevailing depression, of course, will account for a certain number of failures in the transportation business as in other lines, but it seems that there must have been something wrong with the situation when dullness could throw into bankruptcy so large a part as one-quarter of our railways. Probably transportation is the largest single industry in the United States, with the exception of agriculture. Our railways employ nearly a million of men, while many large and small establishments depend upon the orders of the railways for their trade. The money disbursed by the transportation interests in wages and in purchases of material and supplies is of great importance to the whole country. If, therefore, we as a people wish for such a reasonable prosperity among the railways as will help forward all business interests, we should consider whether the charges of the railways are not now too low to support the capital necessary for the safe and speedy transportation of passengers and freight. There is no single question before our business men of greater importance than this. If our rail carriers cannot earn a fair return upon the capital, they cannot buy supplies or extend their facilities or even give good service to the community.

The reform most urgently needed is such a modification of the interstate commerce law as will permit the railways to pool their earnings and thus to maintain the tariff rates which, as everybody knows, are not adhered to. Rate-cutting brings with it two great evils. It has diminished the earnings of all the carriers below what is reasonable, until we see the present unfortunate condition of things as a direct result. On the other hand, rate-cutting brings about that worst of discriminations, —the discrimination between persons. If one of two trades-people gets a much lower rate on his products than the other, the latter is sure in time to be forced to the wall. Just how far the principles of "wholesale" and "retail" trade should apply to transportation is a disputed question, but no matter what arguments there may be in behalf of the large firm or the large establishment, such differences certainly ought to be stated openly so that every one may know just what the transportation charges are. No doubt the difference between the rates charged one merchant and those charged another, or between those charged one manufacturer and another, under the present cutting is greater than any theory of wholesale and retail dealing would favor as an open policy. Nor do we need to fear any extortion on the part of the carriers if allowed to pool. Commercial conditions in the United States are set in favor of low charges. Our great river, lake, and canal systems of water transportation are in themselves enough to limit the rail charges in any event. To this may be added the fact that the traffic

now moving is carried from place to place on a slender margin of profit to the producer. If all the possible profit were taken away by an advance in freight-charges the traffic would cease to move and the railways as well as the manufacturers would lose their business. Enlightened selfishness, therefore, may be relied upon to keep the railways from committing a blunder which would destroy their own traffic.

ONLY 500 miles of new railroad, approximately, were laid in the United States during the first six months of the present year. Compared with the previous records this is an abnormally small addition; not enough, indeed, for the growing needs of our people in normal times. No doubt this small mileage built thus far in 1894, together with the restricted use of iron in other departments, is one reason for the decline in the production of pig-iron. The report of the American Iron and Steel Association shows the total production of pig-iron for the first six months of the current year to have been 2,717,983 gross tons of 2240 pounds. In the second half of 1893 the production was 2,561,581 tons, but in the first half of 1893 the record shows an output of 4,562,918 tons, thus showing a very heavy decline for the second half of 1894. What this means may be seen from a brief table of output since 1886:

YEARS.	Gross Tons.
1886	5,683,329
1887	6,417,148
1888	6,489,738
1889	7,603,642
1890	9,202,703
1891	8,279,870
1892	9,157,000
1893	7,124,502

If now we take the total production from July 1, 1893, to June 30, 1894, we find that the product, 5,279,567 tons, is the smallest since 1885. As contrasted with the years since 1890 the falling-off in pig-iron production is very large, and shows how great is the stagnation in general business and among the railways. The production of the next six months is expected to show a slight increase, according to the *Iron Age*, but it is not pleasant to read that on June 30 only 108 stacks, including all kinds of fuel, were blowing in the United States, while no fewer than 408 stacks were idle. Better rates for the railways would do much to help the iron trade out of this "slough of despond."

IN connection with the subject of cut rates is the question of the payment by the carriers of the debts thus agreed upon,—in other words, the payment of rebates. The disclosures made in Atchison affairs have created a profound sensation among investors both in Europe and in the United States. According to the public statements the net earnings of this company have been greatly overstated since the reorganization of 1889, partly because the rebates paid by the company were not deducted from the gross earnings, as they should have been. For the system of rebates the public must bear its share of responsibility. In their national and state laws they practically ask the railways to compete keenly with one another, while at the same time maintaining their published tariffs,—two things which destroy each other. No doubt the roads are more or less guilty of paying rebates. To stop the practice is impossible without a removal of the cause; but in the Atchison case the complaint goes further and asserts that the money thus paid was not properly accounted for, so that the reported earnings of that company have been for years overstated. Thus confidence in American bonds and stocks has received another blow and the business recovery, as far as the railways are concerned, another setback. This is greatly to be regretted, because unemployed men and unemployed factories are alike waiting for the revival of business on the railways to secure expected work. But this revival cannot come so long as the investor is led by such disclosures as these of the Atchison to fear that he will lose his money.

THE Atchison disclosures raise another point. Railway bookkeeping as an art has not progressed with the increases in the size of the systems and the amount of traffic carried. An instance of a possible

reform is in the profit and loss account. One railway prints what it calls a profit and loss account in its report, but when looked at closely this account is found to be an income account and nothing else, since it pretends to give only the results of the operation of the road for the fiscal year covered by the report. Another first-class road two years ago charged off to profit and loss some old equipment, although the item called by this name was merely a balance between the debit and credit sides of the general balance-sheet. A large system should have an income account and also a profit and loss account. The former should show the results from operation for the year; the latter should gather together all the items from year to year so that, by grouping these, the stockholder and bondholder may be able to tell just what has become of the road's money. A profit and loss account in the true sense is kept by the Northern Pacific Railroad Company, although not given in sufficient detail in the printed reports. If more particulars had been stated the stockholders of the Northern Pacific would have seen at a glance just how much of their money had gone to pay for losses on the roads purchased or leased in order to form the Northern Pacific system. Mr. Stephen Little, who examined the Atchison accounts for the reorganization committee, is comptroller for the Denver and Rio Grande railroad and annually presents in the reports of that company statements of accounts which are models of railway bookkeeping. In these reports the profit and loss account is properly handled.

ONE matter growing out of the Pullman strike deserves discussion, and that is the great length to which our railroad companies have gone in furnishing luxurious fittings for their drawing-room-cars, sleeping-cars, and even ordinary coaches. It has been assumed that the traveling public wish to journey by rail in cars upon which the utmost amount of money has been lavished in decorations. Let any reader, the next time he enters a Pullman or Wagner car, note the costly finish which he will find throughout the car. No doubt one thing which has prevented a reduction in drawing-room fares has been the increasing cost of these cars. Some of our newer sleeping-cars are reported to have cost $25,000 or $30,000 each. Nothing is clearer than that equally good accommodations could be afforded for the traveling public in cars costing but half these sums, because not so finely finished with frescoes or embossed work. The effect of this misplaced elegance in our drawing-room-cars has been to lead the railway companies into competition with each other in more expensive fittings for day coaches also. Our passenger equipment, generally speaking, surpasses in finish and elegance the homes of the majority of those who ride in them. Comfortable seats are indeed a necessity and so too is the often neglected matter of good lighting, but when we get beyond these items of necessity there is a large room for economy in the amount of money which the railway companies have lately been spending in mere ornament. It would be better for all concerned, for both the drawing-room-car companies and the railways, to build their cars and coaches hereafter on a more simple pattern, dispensing with the mere luxury of decoration.

MR. HENRY C. THOMPSON read an interesting paper recently before the Civil Engineers' Club of Cleveland on the improvements of grades versus increase in weights of locomotives. Broadly speaking, it may be said that the modern railway problem consists in hauling the largest possible load of freight from place to place. With the constant fall in the average rate of transportation the pressure upon the railways for some counterbalancing economy has been very great. This economy the railroads find in the increased lading of the average freight-trains. With most railways this object has been achieved by increasing the weight of locomotives, whereby longer trains can be hauled over each division. This, in turn, has involved a very large expenditure of money for stronger bridges, better road-bed, better cars, and more substantial work generally.

The Chesapeake and Ohio railway is an excellent example of the good effects to be obtained by this policy. Mr. Thompson presents figures to show, however, that the cost of improving the grades on a railroad is about the same as the cost of increasing the weight of locomotives, added to the indirect cost of strengthening the bridges and in other ways bringing up the track so that it may bear the heavier engine-train. Mr. Thompson's conclusion is:

> The foregoing figures indicate that it is true economy, in providing for increase of traffic, to improve the grades of a road rather than to increase the weight of its locomotives; for, although the cost of the improvement is the same in either case, we see that, at the end of the fifteen years assumed, the improvements in the grades remain as a permanent betterment for all time, while the expenditure on increasing the weights of the locomotives must be repeated every fifteen years.

Of course it is presupposed that the character of the country will allow of a choice, and where this is so the experience of the Lake Shore and Michigan Southern, in its policy of reducing grades rather than increasing the weight of engines, bears out Mr. Thompson's views. He believes that where it is impossible to effect a satisfactory revision of grades at reasonable cost it is better to use helpers rather than to rely upon heavy engines for the whole road. No positive rule can be laid down upon this subject, but Mr. Thompson's paper deserves the consideration of all those interested in the problem of increasing train-loads.

SEVERAL railways, notably the Illinois Central, Denver and Rio Grande, and the Chesapeake and Ohio have issued circulars containing the thanks of the board of Directors to the employés who stayed faithfully by the interests of the company during the late strike. This is a graceful compliment and one thoroughly deserved, No one knows better than he who is in the railway service what pluck it requires for an employé to stand fast by the company when his comrades, rightly or wrongly, are going out on strike. To be called a "scab" and abused with all the epithets in the repertory is but a beginning of his trouble. He is in real and daily danger of assault and perhaps serious injury, while possibly he may lose even his life. Under these circumstances the railways which have been in the thick of it may well compliment their steadfast employés openly. As a rule men should not be specially rewarded merely for doing their duty, but the present case is exceptional. On this account some of the stockholders of these companies are willing that some more substantial recognition of the service of the employés should be made, but the difficulty is that the railways concerned have no extra profits which they might be expected to divide with their men. Nevertheless it is reasonably certain that the loyal employés will individually receive such consideration from the railways as will in their individual cases make up the equivalent of a money reward. Such public expressions on the part of railway managers tend to promote good feeling between officers and men.

THE British Board of Trade's return on accidents shows that for the first three months of this year not a single passenger in Great Britain was killed and of employés only one. It is not altogether pleasant to note how greatly the English railways excel our own in this matter of safety. There are indeed causes for the greater number of accidents proportionately in the United States, for safety after all is a commercial thing and has its price. There is no doubt, for example, that some of our most serious accidents would be avoided if we could eliminate the grade crossing, for the crossing of steam-railway tracks by wagons and by trolley-cars affords chances for disaster which no gates can always prevent. Besides that, in the majority of country crossings there is little protection, even a flagman often being conspicuous by his absence. Yet to put a railway track under or over all common roads or streets—a thing insisted upon in England—would cost enormously. One road, the New York Central for example, reports upon its line 936 highway crossings at grade without protection, and 407

such crossings, protected by gates or flagmen. What would be the cost of the removal of these 1300 crossings and how should the expense be divided?

IN the current discussion of the Nicaragua canal it is hastily assumed by some of the disputants that the Transcontinental roads, or, as they are sometimes called, the Pacific railways, are opposed to the project because it would take from them certain overland traffic which they are now carrying. But this is a superficial view of the matter. No doubt the opening of the Nicaragua canal would be attended at first by the diversion from the Transcontinental roads of a certain part of their traffic, yet even this may be easily exaggerated because the canal would compete more with the ships around the Horn than with the rail carriers; but if we look far enough in the future there is no doubt that the ultimate result of the building of the canal will be favorable to the interests of the Transcontinental railways. Anything which will increase the prosperity of a section of our country will be good for the railways which serve it. This is a broad principle which experience has many times demonstrated to be true. If some of the coarser freight hitherto taken by rail should seek the water route, the prosperity which the cheapness would bring would create other shipments for the railways on which a much greater average charge could be collected. The New York Central railroad is in daily competition with cheap boats on the Erie canal, yet the local traffic and travel which seeks this road because of the large number of prosperous cities and towns on it, is the envy of its rivals. In like manner the Lake Shore finds lake competition nearly all the way from Buffalo to Chicago, and yet here again we find this road to be considered one of the most prosperous in the United States There is no reasonable doubt that the completion of the Nicaragua canal would give to the Transcontinental railways in the long run more traffic than it would withdraw from them.

THOSE who are interested in the matter of lighting cars will find in the paper by Mr. M. B. Leonard, read before the Association of Railway Telegraph Superintendents, a mass of interesting facts not heretofore brought together. The conclusion of Mr. Leonard's figures is that the cost of fitting up a train with electric-lighting is about $6000. Comparing the expense per car per day of ten hours' lighting, of the three systems, and basing the illumination per car at 148.8 candle-power for this purpose, the cost is stated to have been for the last year as follows:

Pintsch gas	$0.943	per car per day.
Electric light.....	.977	do.
Lewis (new) electric system	.479	do.
Oil...	.636	do.

The Lewis system takes the motive-power from the car-axle. Speaking of the lighting of our trains by electricity Mr. Leonard concludes: "It is evident that the lighting of our passenger-cars by electricity has passed far beyond the experimental stage. It is, therefore, greatly to be hoped that the superior advantages of electricity will ere long cause it to be utilized so largely that not only will our trains be illuminated by it, but that the weary traveler may in winter be warmed by heaters and in summer cooled by fans operated from electricity generated by the least expensive of all methods—the movement of the car itself." All of which is respectfully commended to those companies which still darken their cars by the use of oil, particularly the Manhattan Elevated railway of New York.

MINING AND METALLURGY

Conducted by Albert Williams, Jr.

ONE of the correspondents of this Department, writing about a certain comparatively unexplored tract of country as a promising place for prospecting, describes it as a locality where granite is associated with volcanic rocks, and cites a long list of similar petrographic regions which have proved rich in precious-metal ores. This raises a very interesting point in economic geology—one which has given rise to much discussion and which is of quite as much practical import as of scientific interest. It is true that there is hardly a gold- or silver-mining district, if any, where volcanic rocks do not occur either in immediate association with the ore-deposits or somewhere in the near neighborhood, as sheets or intrusive dikes of "porphyry" (andesite, trachyte, rhyolite, phonolite, diabase, basalt, etc.). This generalization holds good also as to most copper districts, and, with more exceptions, to those of lead, and especially where the ores of these base metals carry silver and gold also. These associations of granite with the eruptives are considered favorable indications by prospectors, and experience has fully sustained the belief. Both prospectors and geologists seem to have the idea, however, that in some unexplained way the volcanic masses have induced the ore-deposition; and, while it may be that in some cases the ore was derived from these rocks and also that there may be some foundation for the theory which ascribes ore-formation to electrochemical agencies brought into action by the contact of dissimilar rocks, the explanations given are not wholly satisfactory or applicable in a general sense. It seems more rational, and more comprehensible, to suppose that the two results, the ore-bearing veins and the neighboring eruptives, are merely distinct phenomena traceable to the same cause and not, as a rule, otherwise related. If there were a causal relation, then the ore would be expected to be found immediately at the contact and following it, which is seldom the case. That cause is the dynamic activity which on the one hand attended and permitted the outbursts of eruptive masses and at the same time fissured, faulted, and shattered the older rocks, thus providing the necessary channels in which ore-bearing solutions might be precipitated. It is never safe to advance or depend upon any single theory or explanation to cover all cases, for the more the study of ore-deposits progresses, the greater is shown to be their diversity; but the simple explanation now offered may be satisfactorily applied to a very large number of typical occurrences, and free us from the necessity of seeking for more abstruse and remote causes. In those instances where the ore is unquestionably derived from the "porphyry," as in the limestone-porphyry contacts, this explanation of course does not apply; nor to another familiar type of deposits, the contacts of granite with metamorphic slates, etc. But so far as it goes it seems to be a reasonable one. There are examples, as where granite is traversed by basalt dikes, where the ore certainly did not come from the barren basalt, but by lateral secretion from the granite country rock, which gives small assays; and in such cases the dikes were not the cause, but merely an accompaniment, of ore-deposition. All this does not in the least invalidate the importance of these combinations of rocks as a guide to the prospector.

IN a work on the coal-reserves of Europe and their exhaustion, Herr R. Naffe makes the following estimates of the available coal remaining in the various coal-fields, counting only seams of workable thickness not lower than 1200 meters (3925

feet): Germany, 112,000,000,000 metric tons (including some lignite); Great Britain and Ireland, 198,000,000,000 tons; France, 18,000,000,000 tons; Austria, 17,000,000,000 tons; Belgium, 15,000,000,000 tons; total for Europe, 360,000,000,000. According to these very liberal estimates there seems to be no immediate danger of a complete exhaustion of Europe's coal-resources. At the present rate of output—which, however, is certain to increase—Herr Naffe considers that it would be 800 to 1000 years before the German supply (which he considers will last the longest) is mined out. These estimates are much more favorable than those usually made, and are probably extreme. If the rapidly increasing rate of production is taken into account—and no one can prophesy how much this will increase in the future—the time of final exhaustion of European coals is very much nearer. It is within the bounds of possibility, however, that before that time is reached human ingenuity will have supplanted coal and steam by solar heat, wave and tidal power, or some other natural agency, in connection with electrical distribution of heat, power, and light.

THE problem of using low-grade crude iron and steel and scrap metal so as to produce homogeneous castings is one that has long troubled the minds of foundrymen. Mr. Walter J. May, in the *Colliery Guardian*, describes the working of a new flux, with which, he says, the commonest scrap iron has given results equal to selected metal, with both crucible and cupola work. Metal which poured like badly-mixed porridge when used in the ordinary way, after the addition of the flux became quite fluid, pouring freely and leaving the ladle clean and free from adherent metal. The castings showed a great difference, that from the unfluxed iron being very dirty and the edges faulty, while that which had the flux added was both clean and sharp. The flux contains metallic iron and sodium, and chlorids of both metals, and is in the metallic portion an alloy of iron and sodium. But even at the present reduced rice of sodium such a material must be rather expensive. If that is not a prohibitory objection, and the action is as good as reported, the new flux is a material that will attract the attention of all workers in low-grade iron and steel. Scrap as bought from junk-shops and other collecting centers is composed of all classes of metal, and, while it happens that a little high-grade metal may be present, it is a pretty sure thing that plenty of poor stuff will be found. As Mr. May says, what is needed in dealing with poor pig or scrap metal is a flux that will give a ladle of clean metal in a fluid state, and this without necessitating any outlay for plant. If the new material accomplishes this at a reasonable cost it marks quite an advance in foundry practice.

A NOVEL method of retorting small quantities of gold amalgam is announced by the *Australian Mining Standard*:

> We recently asked a miner who was getting fine gold by sluicing how he saved it. "I use quicksilver," he said, "and squeeze it through calico, and when I have got the amalgam as hard as I can—" "You retort it," we said. "No, I don't and yes, I do—I don't as you mean retort, but I do as I mean it myself. I get a potato, cut off one end, and scoop out a cavity in it large enough to take my ball of amalgam. I next take a spade or piece of flat iron, and place that over the fire; and then upon that I place the potato with the cut side down. As the amalgam gets hot the quicksilver evaporates and goes all through the potato; but it can't get through the skin, and neither can it escape by the iron, for the spud is stuck to the spade. When it is done I take the spade off the fire and let it get cool, and then I have my gold in a button on the spade and my quicksilver all in fine globules in the potato. I break that potato up under water and I have all my quicksilver."

FOR detecting internal flaws in iron and steel masses Captain de Place, of Paris, has invented a system and an apparatus, called the "schiseophone," the latter consisting of a small pneumatic tapper worked by hand, and with which the metal to be tested is tapped all over. A telephone having a microphone interposed in the circuit is connected with the tapper, but is placed in a separate apartment so that the

direct sounds of the taps may not disturb the listener who is in electrical connection with the other operator, and gives no sign so long as the sounds are normal, but when a false sound is heard immediately signals to the tapping operator to mark the spot. The design is not merely to detect a flaw, but to locate it.

WESTERN lead-smelting works receive for treatment almost every known ore of the precious metals, with the exception of low-grade gold-quartz. A very common type of ore treated by them consists of mixed sulphids—galena, blende, pyrite, marcasite, arsenopyrite, stibnite, etc.,—which, when present in large quantities, are roasted before smelting, but also enter raw into the furnace charge in smaller amounts. Metallurgists unfamiliar with the conditions prevailing in the far west are sometimes exercised over the loss of a number of possible by-products in the usual system of reduction, and especially on account of the zinc. It is said, for instance, that the smelters are saving lead, and giving their main attention to that while letting zinc, which has a higher market value per unit, go to waste. This is quite true of the usual system, though the "bag" process arrests part of the zinc oxid and other volatile products, and the ordinary flues catch other portions, which however are utilized very imperfectly. Now the facts are these: There are very few lead-mines in the far west which could be operated at a profit for the sake of the market value of the lead, *as lead*. There is always a demand at the smelters for heavy lead-ores, of which the Cœur d'Alene mines and a few others produce large quantities, but this demand again is not for the lead as such, that is, to turn out lead for the market, but because it is the basis of the whole smelting industry in which lead is used as a collector of the precious metals. Besides this, the lead of the far west always carries more or less silver and a little gold. Although called lead-smelting, and rightly so from the technical standpoint, it is really, and from the commercial point of view, a process for the extraction of silver and gold in which lead is used as the collector of these metals. The lead itself is a by-product. It has a market value, of course, and, after being turned into base bullion and subsequently refined, the proceeds form a large item of income. On its own account, however, very little lead would be produced west of the Joplin district of Missouri and Kansas. The base bullion, requiring not merely a softening operation but a true refining process, yields small quantities of other by-products, of which little account is made. As to zinc, so far from yielding a valuable by-product, it is regarded as a positive detriment in the lead-smelting process, and ores containing it are subject to deductions in price. The blende is also badly mixed with other volatile minerals, so that a distillation process would give an impure zinc. When the western country becomes more thickly settled, so that there is a larger local demand, and the long hauls to market are unnecessary, it is probable that the whole system of ore-reduction may be changed, and brought into something like that of Germany, where practically everything of value is worried out of the ore by an elaborate system of concentration and classification, followed by special processes for the different classes of material. Under existing circumstances this would be impracticable, as would be also any general wet process, with electrolysis. The enormous cost for additional plant, the relatively high wages, the cost of transportation of ores from mines to works and of products from works to markets, stand in the way. While it would be desirable to utilize all the numerous accessory metals and substances—zinc, antimony, arsenic, sulphur, and many others in less amount—present in the mixed ores, it must be remembered that the lead-smelting industry of the west has been developed to a very high degree of efficiency, regarded in connection with the peculiar conditions; and that even under obvious disadvantages it now leads the metallurgical practice of the world in its own sphere. To have brought the cost of smelting to within $4 per ton of neutral ore, at works to which every item of supplies—ore, fuel, flux, etc.,—has to be transported greater or less distances, and where

labor is by no means cheap, is certainly a great achievement; and to do this with a technical success measured by a recovery of 95 per cent. of the silver and lead, and more of the gold, is a still greater achievement. Those who find fault with present western methods do not realize either the intricacy of the conditions or the remarkable progress that has been made.

THE loss of gold and silver in the scorification assay is a considerable, though rather an indefinite, quantity. Messrs. W. P. Mason and J. W. Bowman have been making some experiments to determine the amount of this loss, and communicate their results to the *Journal of the American Chemical Society*. From a large number of assays they found that with silver the loss by the entire process was 2.54 per cent., of which 1.99 per cent. was in cupellation and 0.55 per cent. in scorification. With gold the loss in the entire process averaged 0.87 per cent., of which 0.296 per cent. was in cupellation and 0.574 per cent. in scorification. These results show larger losses than is commonly supposed, and perhaps larger than is usual. But they serve to explain in part some of the exceptionally high records made in smelting, where the comparisons are based upon the scorification assay. It remains now for a new series of experiments to be undertaken to determine losses in the crucible assay for gold and silver. Some figures are quoted in the books, but they are not regarded as altogether reliable, and there is always the personal equation of the assayer to be taken into the account. In his new book on assaying, Mr. H. V. F. Furman advocates the determination of silver in two or more portions of the ore by scorification, and the gold in two or more portions by crucible assay. This is the Colorado practice. Most ores yield higher silver returns by scorification and higher and more uniform gold results by crucible assay. The reason stated by Mr. Furman why the crucible method gives better results on gold, is that it allows larger quantities to be taken for assay, and hence a larger gold button for weighing. Both methods can of course be made more accurate by running a number of assays and combining the buttons in parting. The claim for the remarkable delicacy of the fire assay for gold and silver still holds good, if care is taken and all sources of error are understood and proper allowance made. In ordinary work the error should not be more than half an ounce silver (and much less gold) per ton; while in delicate scientific experiments, using specially prepared litharge and micrometer measurement of buttons instead of weighing, Mr. J. S. Curtis has determined (and proved) quantities of silver down to 5 and 3 cents a ton of ore.

IN a paper recently presented before the Engineering Society of the South, Mr. A. Porter Gaines described the modern blast-furnace stack, stating that the universal construction of a modern stack is a round sheet-iron shell somewhat in the form of a truncated cone, supported at the base, which is the widest part, by columns. This shell is lined with fire-brick, having a packing space of 3 to 5 inches between the shell and the brick, which is filled with some light loamy material. The points of difference are the dimensions of this shell, the height, diameter, distance from hearth or bottom, which shall be supported, and interior shape or lines, as given by fire brick lining. The conditions governing the dimensions are chiefly the character of the stock (fuel, ore, and flux) and the volume of the blast. Modern practice is towards large outputs, and, looking to this end, the dimensions are as large as these conditions will admit. The interior shape is more or less in dispute among furnacemen. It is largely theory as to the mechanical arrangement and chemical changes that material undergoes in the stack, so necessarily it follows that there would be more or less difference as to the interior arrangement of furnace to obtain the best results. Mr. Gaines lays stress upon the fact that conditions are so different in different localities that, in his opinion, it is very questionable whether there will ever be found any specific inside lines that will give universal success. Although wonderful results have been obtained from

the modern blast-furnace, both in low fuel consumption and large output, still it is far from having reached its full development. While the progress of pig-iron making may not be so rapid in the future as it has been in the past, Mr. Gaines believes that it will undoubtedly be changed materially both in construction of plant and practice.

A PLAN worthy of imitation by all mining schools situated in mining localities has been put in practice at the South Australian School of Mines. To meet the wants of prospectors and others interested in mining a "prospectors' class" has been formed, in which technical matters are avoided as much as possible, the object being solely to enable searchers to establish the presence or absence of minerals of economic value by means of the blowpipe and with such chemical tests as are available to prospectors in the field Instruction is also given regarding the rocks and associated minerals among which search may be prosecuted with the greatest hope of success.

A RECENTLY-INVENTED apparatus for burning anthracite culm consists of an automatic grate which moves sidewise under the boiler at a rate of 3½ to 5 feet per hour, carrying with it the culm, which is heated as it approaches the furnace and is completely oxidized while in it, the ashes being carried away by the movement of the grate. It is claimed that this apparatus solves the difficulties of stoking, avoidance of clinkers, and disposal of ash, while allowing perfect combustion. This is only one of a numerous class of inventions lately announced, for utilizing culm, the successful introduction of any one of which will have a most important bearing upon the anthracite industry, since nearly one-third of the anthracite mined has been and is going into the waste-dumps, where it is not merely a loss but a positive inconvenience and source of expense for handling and for dump-room. Thus far neither the various devices for burning culm under boilers, nor the different methods of briquet-making, nor the production of water-gas, however promising, have done much toward reducing the enormous waste in culm; but it is to be hoped, and may be expected with some confidence, that a successful solution of the problem will be reached before all the available anthracite is mined. The amount of thought and ingenuity that have been bestowed upon the question ought surely to accomplish something on a large practical working scale before long. It is one of the disappointments of this age of boasted economies that the culm problem was not disposed of a generation or more ago. But now there are several directions in which light is beginning to appear, and in the anthracite regions the culm is being utilized quite extensively.

AN electric auger-drill for coal-mining, lately introduced, seems to possess valuable qualities. The drill complete for bituminous mines weighs 1600 pounds, and is capable of developing from 4 to 5 horse-power at the auger (though from 2 to 2½ horse-power is the usual requirement), and has been tested to 7 or 8 horse-power without excessive strain, showing no signs of sparking or over-heating. The largest size drill, of the same pattern, with a nominal rating of 4 mechanical horse-power, is designed especially for anthracite mining, for trimming gangways, taking down roof, and for general rock-work. It is said to have drilled a 2-inch hole 6 feet deep in the hard "boney" in from two to 2½ minutes; while drilling in the coal proper a similar hole has been made in fifty seconds.

THAT must be a wonderful coal-mine which the French are working in Tonquin. It is the Hatou, and is said to yield excellent coal (at present about 500 tons a day) by the simple method of stripping. The length of the seam is stated at 16 miles and the thickness at nearly 200 feet! The published account does not say that this immense thickness is in one solid mass, but it is left to be assumed that it does not mean the total of a series of separated coal-beds. Very naturally this remarkable deposit is described as "practically inexhaustible"—an expression often loosely used in reference to mineral deposits. Accord-

ing to the ratio of reduction in bulk in the formation of soft coal from vegetable matter, as usually estimated, this thickness of coal would represent about 1350 feet of fairly compact woody substance, without allowance for loss; and might furnish some astonishing figures as to the time and the extent of the original vegetable growth required to produce such a mass.

THERE are some peculiar mines. A newspaper describes what it seriously calls an aluminum-mine—meaning a promising bank of pure clay. The writer was once invited by an enterprising but innocent publishing-house, then about to issue a book on mining, to furnish some information on mines of gold, silver, iron, lead, copper, and *brass*. But there are some stone-mines. That the ancients obtained stone by true mining, Mr. Durfee has shown in his admirable paper on "Quarrying Methods of the Ancients" (in the July number of this Magazine); and at present there are a few stone-mines, where the material is of sufficient value to warrant the method.

IRON and steel props cannot be said to have fairly reached even the experimental stage in American mines. Indeed there is no occasion for experiment. The results of European experience, now quite extensive and successful, and of the few trials in the United States, show what may be expected of metallic supports. There is no question as to their great merits. It is simply a matter of relative economy. Under present conditions timber can hardly be displaced by metal except under peculiar conditions, as in exceptionally difficult work, or for permanent openings of the greatest importance, or in treeless regions where freight charges may put timber and metal on terms of greater equality. Steel "tubbing" is of course indispensable in some cases. Iron and steel ladders, head-frames, and guides are also common. No doubt in time we shall use metal props, etc., very largely, beginning with the large eastern coal-, iron-, and copper-mines. It may be added that when we do come to the use of metal in earnest, the props, stulls, caps, shaft-frames, etc., will be of steel rolled to suitable form, convenient for setting and replacing, and shaped in accordance with the stresses so as to use the material to the best advantage. Makeshifts of old rails can have but limited application, though ingenious systems of framing with them have been invented.

A RECORD for fast tunnel driving was made recently in the tunnel of the East River Gas Co. under the East river, New York. In one week the day shift made 48′ 6″ and the night shift 52′ 6″ —a total of 101′. The heading is 10′ 6″ × 8′ 6″, and is advanced in full section. The rock is very hard hornblende-gneiss. This is remarkable work, considering the peculiarly difficult conditions of the locality, and is claimed to be the quickest tunnel-driving of the kind. Four 3½″ Ingersoll-Sergeant drills are used in the heading, mounted on tunnel-columns with arms; two drills on each column. About 15 holes, 9′ to 10′ deep, are drilled by each shift, consisting of five machine-runners and their helpers. Compressed air for running the drills and pumps, and also for ventilation, is supplied by an Ingersoll-Sergeant air-compressor, of the latest improved piston-inlet type, "straight line" pattern, having cylinders 20″ diameter by 24″ stroke, furnishing about 1050 cubic feet of free air per minute.

THE inspector of mines for the North Staffordshire district, England, reports that the use of "safety" or so-called flameless explosives continues to increase in that district, displacing gunpowder, those chiefly used being roburite and ammonite; trials also being made with some new brands. The water or gelatinous cartridge continues in use, with geglinite and tonite. No injury from fumes by any of these explosives has been complained of. The inspector says that the wisdom of adopting these safer explosives (with electric firing) in dusty or gaseous mines is not to be doubted.

CIVIL ENGINEERING

Conducted by John C. Trautwine, Jr.

DURING recent years the harbor of Genoa, Italy, has been thoroughly improved and enlarged by the construction of two new breakwaters, respectively 4800 and 1600 feet long, sheltering an outer harbor of 250 acres, while in the inner harbor about six miles of new quay-walls have been built and provided with sheds, hydraulic hoisting-machinery, railway sidings, and accessories. Two granite graving docks, respectively 750 and 650 feet long, have also been built, and near them a quarantine station.

The whole cost of the works has been about $15,000,000, and of these $5,000,000 were given by a Genoese nobleman, the Duke of Galliera. Of the other ten millions, eight were provided by the general government and two by the municipality.

The breakwaters are in depths of water varying from 50 to 95 feet, and are of rubble masonry. Each consists of a mound extending up to 20 feet below low-water mark, and surmounted by concrete blocks regularly laid down in steps. Upon these is built in turn a wall of masonry with its top 30 feet above mean water. Concrete blocks were used also for the subaqueous parts of the quay-walls, and are surmounted with masonry. Each of the graving docks is a monolithic structure of concrete faced with granite ashlar.

The construction of these works required 120,000 cubic yards of concrete, 440,000 cubic yards of concrete blocks, and 280 000 cubic yards of brickwork, masonry, and ashlar.

The resident engineers on the works were Chevalier Luigi Luiggi, of Genoa, and Mr. V. Cardi, of Pisa, who, taking advantage of the magnitude of the undertaking, instituted and carried out a most elaborate series of experiments on concrete and masonry. The experiments extended over a period of twelve years, and embraced a vast amount and variety of materials. Their results have been published in Italian by order of the government and adopted as a standard work for Italian maritime engineers.

Much attention was given to the properties of pozzuolana, a volcanic sand found in large quantities near Naples and Rome, which forms an excellent hydraulic mortar when mixed with ordinary lime. In Italy, where Portland cement is very costly, this mortar of ordinary lime and pozzuolana, which costs little more than sand, is very extensively used. It was employed by the ancient Romans, and there are still existing in Italy many harbor-works where it has remained in perfect condition for fifteen or twenty centuries.

Many experiments were made to determine the best proportions of cement, sand, gravel, and water for different purposes, the influence of temperature and of frost on cement mortars, the use of fresh water and sea-water for mixing, etc.

Special attention was given to the porosity and permeability of mortars,—subjects upon which but little has been written, but which are of the greatest importance in the construction of works which must remain tight under the pressure of water. The porosity of mortars depends upon the existence of voids of three kinds: first, those existing between the grains of sand or pozzuolana and not completely filled by the cement or lime; second, those due to the air which adheres to the surfaces of the grains; and third, those left by the evaporation of the water used in the mixing. These three classes of voids have been thoroughly investigated and discussed.

The conclusions arrived at are: that cement mortars are less porous than those made of hydraulic lime and sand or of ordinary lime and pozzuolana; that cement

mortars made with coarse sand are less porous than those where fine sand is used; that neat cement mortars are more porous than those made with sand; and that the proportions between the voids and the apparent volume of the mortar may vary from 12 to 46 per cent. The lowest porosity, 5 per cent., was found in a concrete composed of 700 pounds of Portland cement, 1 cubic yard of mixed sand, and 1 1-4 cubic yards of small gravel.

Paradoxical as it may seem, the experiments showed that the permeability of mortars, so far from being a consequence of their porosity, is in fact almost inversely proportional to it. The exhaustive experiments made in this connection showed: that with the same proportions of cement, mortars made with fine sand are less permeable than those made with coarse sand; that, with the same quality of sand, permeability decreases as the proportion of cement increases; that mortar made with neat cement is the least permeable of all; that concrete made with 700 pounds of Portland cement, 1 cubic yard of mixed sand, and 1 1-4 cubic yards of small gravel, and molded in the shape of a hollow cylinder with a shell 2 1-2 inches thick, was impermeable under a head of water of 13 feet, while a mortar made with the same amount of cement and sand, but without gravel, and molded as above, was somewhat permeable. Under a head of water of 27 feet, the concrete was barely permeable, while the mortar of cement and sand was very easily permeated. Concrete made with 1150 pounds of Portland cement, 1 cubic yard of mixed sand and 1 1-4 cubic yards of small gravel, mixed very accurately with the amount of water strictly necessary to work it up (say 1-3 cubic yard of water), was impermeable under a head of 40 feet.

The effect of exposure to wave action, the labor required in the construction of different kinds of masonry, and the adhesion of mortar to different materials were carefully studied.

MR. L. D'AURIA has recently constructed under his patents a direct-acting, non-rotative pumping-engine using steam expansively in a simple cylinder by means of quick cut-off valves. It is claimed that the high-duty attachments already in use, while they enable steam to be employed expansively in direct-acting non-rotative pumping-engines, cannot be used in combination with a simple cylinder with any cut-off, since they can adapt themselves only to a certain variation of the propelling force of the engine. In other words, the engine must be made to suit these high-duty attachments in order to maintain satisfactory results, whereas the device employed by Mr. d'Auria adapts itself to every condition of the engine. It consists simply in fixing upon the piston-rod of the engine, a plunger working in a special cylinder whose heads communicate with each other by means of a long pipe. Both the cylinder and the pipe referred to are kept constantly and absolutely full of water by means of a simple automatic feed-device, so that at each stroke of the engine the mass of water in this cylinder and pipe must be set in motion by the plunger. This mass, in acquiring its velocity, absorbs almost all of the surplus of work done by the engine during the early part of each stroke, during which the steam-pressure line ordinarily rises considerably above the line of resistance, but the energy thus imparted to the water in the pipe is given up by it again to the plunger during the latter part of the stroke, when the steam-pressure in the cylinder is less than the resistance. By properly varying the length of the pipe, its diameter and the diameter of the plunger, any desired piston-speed can be obtained under given conditions of steam-expansion. The plunger is provided with a series of small holes in its periphery near each end, so placed that the water pressing the plunger forward during the latter part of the stroke is allowed to flow through them when at a very short distance from the entrance end of the stroke. Its pressure upon the back of the plunger is thus relieved, and all danger of striking the cylinder-head is thereby avoided, even though there may by accident be some residual energy in the liquid mass at the end of the stroke.

The engine was constructed in the shop of the Adams and Price Locomotive and

Machine Works, Nashville, Tenn. It is a duplex, simple, non-condensing engine, cutting off steam at about one-fourth of its stroke. The diameter of the steam-cylinder is 12 inches, the diameter of the pump-plunger 6 inches, and that of the plunger of the regulator 8 inches, all with a nominal stroke of 12 inches.

The regulator pipe is 4 inches in diameter and about 45 feet long, forming a U about 20 feet in length, lying horizontally under the engine. Its action prevents any jerk or sudden change of motion.

Disinterested experts who have watched the working of this, the first engine of the new type, are enthusiastic in their admiration of its results.

A valuable feature developed during the experiment is the ability of the engine to run as an air-compressor under steam-expansion with full stroke.

The object of the inventor in constructing this first engine was to test the adaptability of his regulator to any variation of the propelling force of the engine, knowing that, if good results were obtained with an engine cutting off steam in a simple cylinder at one-fourth of the stroke, still better results, if possible, must attend its application to engines with compound cylinders, because in such engines the variation of propelling force is less trying.

The regulator is self-lubricating, and no mechanism whatever is employed in its operation. It therefore requires no special attention, and the engineer in charge has no more trouble or responsibility than with an ordinary low-duty engine.

IN THE ENGINEERING MAGAZINE for June mention was made of a suggestion by Mr. M. J. Murphy, street commissioner of St. Louis, for the holding of a national convention of members of boards of public works, with a view to the interchange of ideas and of information respecting municipal government and municipal works. Nothing need be said to impress upon the observant inhabitant of any large American city the desirability of holding such a convention; and it is therefore gratifying to note that Mr. Murphy's proposition has now taken definite shape in a call for such a convention, to be held in the city of Buffalo, N. Y., during the current month. That city was chosen, we are told, "both because of its geographical location and because of the enterprise and advanced ideas of the members of its board of public works and its large area of improved and paved streets."

AMONG the interesting objects to which the attention of the eastern members and guests of the American Society of Civil Engineers was called, on their way from New York and Philadelphia to Niagara Falls to attend the annual convention there, was the big fill, 145 feet deep, by which the new line of the Lehigh Valley railroad along the east bank of Seneca lake, crosses Breakneck hollow, one of the deep and steep and rocky ravines which discharge their waters into the lake on that side. The fill is 1100 feet long, with a spread at the deepest portion of about 400 feet, and required 640,000 cubic yards of material. The stream is carried under it through a semi-circular arch culvert 20 feet in diameter. In beginning the construction of this culvert upon the original location, it was found that this had been placed in what was evidently an ancient stream-bed; for, instead of the rock that was expected in view of the outcrops just above and below the site, it was found that a bed of compact blue clay extended to a depth of nearly forty feet below the bed of the stream, as tested by sinking a 6-foot well. The axis of the culvert was thereupon shifted, parallel with itself, a distance of 125 feet, and was located upon the top of one of the two rocky cliffs which once, no doubt, formed the banks of the ancient stream. This change involved also a shifting of the alignment of the road some 250 feet upstream. The rock, however, fails under one of the four wing-walls, and this portion was constructed upon a foundation of timber and concrete resting upon the blue clay. During the two years that have elapsed since construction, no perceptible settlement of this portion has taken place. The work was under the direction of Paul S. King, the chief engineer of the new line.

AT a recent meeting of the Western Society of Engineers, Mr. Charles V. Weston read a very interesting and instructive paper describing the construction of a tunnel designed by Mr. Samuel G. Artingstall, and carried under the Chicago river for the West Chicago street-railroad. This tunnel, which, with its approaches, is a little over 1500 feet long, passes under the river near Van Buren street. The depth of the river is about twenty feet. In order to avoid accidents to passengers, such as have occurred in the narrow tunnels of some of the earlier lines, this tunnel was given what otherwise would have been an excessive width, allowing about 5 feet clear space between the car-bodies and the wall of the tunnel, and over 4 feet between two passing car-bodies.

The portion immediately under the river was constructed in two coffer-dams, occupying respectively and successively the western and eastern channels of the river, one channel of course being always left open.

The original plans involved the underpinning of the foundations of several buildings under which the tunnel passed, but, as the contractors were given the option of removing these buildings and rebuilding them after the completion of the tunnel, they chose the latter alternative, believing it to be the cheaper and the less dangerous.

To protect the tunnel from leakage through its roof and side-walls, an asphalt mortar composed of Trinidad asphalt and gypsum was used in the outer courses of the brickwork.

NOW that the opponents of the scheme for a miscalled "boulevard," to extend from the new Broad-street station of the Pennsylvania railroad northwestwardly to the southern extremity of Fairmount Park, in Philadelphia, have secured its defeat through a veto by the mayor of the ordinance passed by city councils ordering its construction,—a veto based chiefly upon the far more urgent necessity of many other matters, prominent among which was a radical improvement of the water-supply,—the Philadelphians are beginning to look for signs of action leading to the introduction of these more urgent improvements. The Citizens' Municipal Association's Committee on water-supply and sanitation, at a recent meeting, ordered that a communication be transmitted to councils, endorsing the plan of water-supply extension proposed by Director Windrim, of the department of public works, which plan had already received the approval of the mayor. This plan involves the impounding of the waters of the Perkiomen and Tohickon creeks, affluents of the Schuylkill and Delaware rivers respectively, and the construction of an aqueduct about twenty-eight miles long, to conduct those waters to existing reservoirs within the city limits,—notably the East Park reservoir, which is much the largest and one of the most recently constructed of the city reservoirs, and the large high-level Queen Lane reservoir, now nearing completion. The cost of the work is estimated at about $9,000,000 and councils are asked for an immediate appropriation of $4,000,000, in order that a portion of the work may immediately be put under contract.

The supply here contemplated will be supplementary to that now derived from the Schuylkill river, and it is argued that the diversion of the Perkiomen into the aqueduct need not materially diminish the available flow of the Schuylkill, inasmuch as the storage reservoir will be supplied chiefly by the storm-water flow, most of which might be expected to flow past the city's pumps, unutilized in any case. The impounding of the waters of the Perkiomen was proposed by Chief Engineer H. P. M. Birkinbine as far back as 1865, and the project has been periodically before the public ever since. It has of course received careful study, and a measure of approval, from the various boards of experts who have from time to time investigated the subject of the city's water-supply. A powerful argument in favor of this plan is the claim that it may, when occasion and opportunity arise, be made the nucleus of a more far-reaching scheme by which water may be taken from the upper Lehigh and Delaware rivers, which, no doubt, will

ultimately be required. In the meantime, the city is endeavoring to keep pace with the growing demands of the population by increasing its pumpage capacity. To this end, two new vertical triple-expansion pumps, to raise 30,000,000 gallons daily each, are now being erected at the Spring Garden works. These are the largest works in the city's plant, containing nine pumps which embrace a very wide variety of design, and which lift in all about 150,000,000 gallons daily, or more than all the other works combined. The two new pumps will be the largest in the city service.

The objection urged against the Perkiomen plan at the citizens' meeting by a gentleman who is very familiar with the stream, that in dry weather its visible flow is practically *nil*, is met by the fact that, with its water-shed of more than 200 square miles and an annual rainfall of over forty inches, it must furnish a very considerable available supply, whether that supply be visible or not, and that a dam, sunk to a proper depth, will bring the major part of that supply into its reservoir. It is estimated that the Perkiomen and Tohickon together will furnish more than 200,000,000 gallons daily, or a little more than the present pumpage. The fact that this enormous quantity is consumed, or in some way or ways disposed of, by a population of say 1,200,000, indicates that there is a fine opening in Philadelphia for the meter-man. Whether a reliable meter exists or not, the fact that the water one uses and wastes passes through a machine which adds to his bill every spoonful consumed, must certainly tend to the prevention of waste. If it had no other result than to stop the indiscriminate washing of sidewalks and marble facings, by which the Philadelphia housewife has excited the risibles of the whole country, it might be well worth the cost, as a mere matter of personal convenience.

IN this Department of the Magazine for August, considerable space was devoted to a study of the reports of the city engineer and the water-works department of the city of Boston, and we are now in receipt of the report of a joint board appointed by the legislature and composed of the board of metropolitan park commissioners and the now justly famous Massachusetts state board of health. The duty of this board was to "investigate the sanitary condition and prepare plans for the improvement of the beds, shores, and waters of the Charles river, between Charles-river bridge and the Waltham line on Charles river, and for the removal of any nuisances therefrom." Mr. F. P. Stearns was appointed engineer of the board, and its report embraces one from that gentleman. The board finds that the increase of pollution of the river has driven away the better class of dwellings which formerly lined its banks, and has caused them to be replaced by manufacturing establishments and by the dwellings of those who are not in a position to be over-scrupulous about the character of their surroundings. Even in its lower reaches, where it passes through the fashionable Back Bay district and where its waters receive the purifying effects of great volumes of salt-water brought in by the flood-tide,—"even here the river has ceased to be a welcome neighbor, except so far as the views of the distant hills to the north and west are enhanced by the water in the not too near foreground, a foreground consisting of a poorly-kept alley-way behind a line of unsightly sheds and stables situated at the rear of the lots on the north side of Beacon street; a rude stone wall, upon which grow tufts of seaweed and unsightly grasses, holding, as sponges do, the floating putrescible materials that come in contact with them; and, at the base of the wall, at low tide, a muddy expanse of many acres, marred by rubbish of every description."

It has been generally believed that the steady increase of malaria in the Charles valley was closely related to the increase in the pollution of the stream, but a careful sanitary survey of the district by Dr. Robert W. Greenleaf fails to show clearly the existence of any such relation. The cases of malarial fever discovered in the district were satisfactorily accounted for by the existence of local conditions independent of the state of the river, or by the

exposure of the victims to malarial influences in other regions.

The board believes that the dredging of the exposed flats and the continuation throughout the entire stretch of a substantial and handsome embankment like that constructed by the city at Charlesbank would be too expensive a remedy and that the rising and falling of the tide would soon cover the walls with offensive growths such as already disfigure those at Charlesbank. The board therefore recommends rather the construction of a dam near the lower end of the stretch in question, and the maintenance of the level, in the basin thus formed, at a nearly constant elevation about seven-and-a-half feet above ordinary low tide, or two-and-a-half feet below ordinary high tide. This will permit the utilization of the sea-water to counteract the fouling of the fresh-water stream, and will at the same time give ample opportunity of wasting any excess of stream-flow at low tide. The dam is to be provided with a lock, of sufficient size to pass the largest vessels that navigate the river, but for small boats it is proposed to provide a run-way, like those used at the weirs on the Thames, or some other convenient means of passing the dam. The dam is designed with a width of 100 feet, and will thus provide a foundation for another roadway between Boston and East Cambridge. The cost of the dam is estimated by Mr. Stearns at $660,000, and the basin formed by it will contain 3,300,000,000 gallons of water, which will be replaced, with the average flow of the river, once in fifteen days, and, with the minimum and maximum flows, in eighty-two days and in one week respectively. The area drained by the river above the proposed dam supports a population of 321,000.

It has been persistently urged that the damming of the streams entering the harbor must exert upon the currents in the harbor an effect prejudicial to the harbor itself, and this view is sustained by the report of a board appointed in 1859 by the United States government at the request of the Boston city government. This board reported that the upper harbor of Boston could not, in its opinion, afford to lose another cubic yard of tide-water. The present board, nevertheless, holds that the construction of the proposed dam cannot possibly exert any unfavorable effects upon the harbor. The Boston report is embellished with a number of handsome photographic views showing the beautiful character of that portion of the city of Hamburg which surrounds the Alster basins, as indicating what might be expected to follow upon the creation of similar basins upon the Charles.

TRULY a remarkable state of things must have existed at the mining town of Ironwood, Mich., according to a paper presented by Mr. E. A. Rudiger at a recent meeting of the Western Society of Engineers. An investigation, following an outbreak of typhoid fever in the town, developed the fact that carcasses of dead animals had been deposited upon the banks of a small stream, which, after draining a portion of the town, discharged into the river a short distance above the intake of the water-works. The startling feature of the matter is the fact that the carcasses were so placed by order of a member of the board of aldermen and committee on health, and it was perhaps but just retribution that this public guardian himself died of the fever.

THE North-river bridge project has been meeting with opposition at the hands of the chamber of commerce of New York. This body objects to that feature of the design which places the piers beyond the pier-lines on both sides of the river, arguing that the presence of the piers would be in the way of large tows and would interfere with the passage of ice in winter. The chamber proposes a bridge of 3200 feet clear span and 500 feet clear height, and submits a letter from Engineer Roebling endorsing its practicability.

MECHANICAL ENGINEERING

Conducted by Henry Harrison Suplee.

THE present complication between China and Japan is being watched with more than usual interest by civilized nations, and especially by the members of the engineering profession, because it bids fair to furnish a practical demonstration of the real merits of the appliances of modern warfare. Both China and Japan are equipped with vessels, guns, and weapons of all sorts from the leading makers of Europe, and Japan at least has men well trained in Europe and America in the use of all these engines of war. At the same time, most of these expensive pieces of fighting machinery cannot be said to be far beyond the experimental stage, and indeed many of them, so far as operation is concerned, exist merely on paper. Of course it is not the fault of the inventor that a new military appliance does not receive an immediate test in actual warfare, when no two nations are accommodating enough to give him a convenient war to exploit his latest killing device; but now that two so-called barbarous peoples have been so good as to invest millions in purchasing these things and are proceeding to put them to actual use, the scientific world is agog to see how the things will really work.

The writer remembers, as one of the lasting incidents in the once popular children's tale of the "Swiss Family Robinson," the fact that the thoughtful father kept a monkey upon which he tried every new plant found in the wonderful island upon which the family had been cast away. If the monkey was not poisoned by the experimental test the article was presumed to be safe for the rest of the family to eat. The monkey thus served as the object of many interesting experiments in the properties of plants, but sometimes it was rather hard on the monkey. In the present crisis the belligerent nations appear to be willing to play the part of "monkey" for the rest of the world, and it might be in order for the rest of the "civilized" world to wait the result for awhile and see how the new weapons work. The only objection which may be urged against such a course is the possibility that the makers of the weapons may themselves be drawn into the fight, when, of course, it would never do for them to find themselves less expert with the tools of their own inventing than the experienced customers to whom they have sold them.

THE very successful speed trial of the new triple-screw cruiser *Minneapolis* was briefly referred to in these columns last month, and the result is one in which the navy department and the nation may well feel a pardonable degree of pride. Of course the usual amount of discussion about the well-worn subject of speed premiums is now in order and, indeed, the daily press has already again settled the matter to its own proprietary satisfaction. As a matter of fact, however, the whole question of speeds is practically a comparative one, and as usual, when there is serious difference of opinion upon a subject, the comparisons are not always made upon the same basis. We have heard much about the *Columbia* being able to catch the *Paris*, or overhaul the *Lucania*, and, doubtless, if either steamer should be accommodating enough to give the crack cruiser a chance to try speeds the triple screws might show greater fleetness than the twin propellers of the ocean liner. It must not be forgotten, however, that the four hours' run upon which the record of the cruiser is made is accompanied with all the advantages which belong to a trial in the hands of the builders, and all that picked coal, clean bottom, reduced top-hamper, and general high-pressure on all

individuals to "push things" can do. Just what the crack liners would do under such favorable conditions no man knows, but until the cruiser has equalled the record of the merchantman in crossing the Atlantic at top speed, with commercial coal, with engines running twenty-four hours a day for six consecutive days, and with the every-day firing which accompanies commercial service,—not until then will it be in order to say whether the cruiser would catch the merchantman, or the merchantman show her stern for a brief period to the record-breaking man-of-war!

THE method adopted by the steamship companies for testing their vessels is one which, while perhaps rather more trying to the builders, appears likely to give results of more permanent value to the owners of the vessel. An ocean liner often remains in the hands of the builders until she has made several trips across the Atlantic, and it is only after everything has been demonstrated to be in first-class order, and all speed requirements fully met under ordinary operative conditions, that the ship is finally accepted and turned over to her owners. While of course it is not to be expected that the builders of a war-ship should stand the expense of a cruise, just to see whether or not everything is all right, yet it does seem as if the large sums paid out as premiums would be better expended if used in paying for a trial cruise of moderate length, during which time the vessel should still be "in the hands of the builders" while under critical inspection of government engineers. A speed made under such conditions, while perhaps not so great as that made under the present "spurt" system, would be one which the government could reasonably expect to be repeated whenever occasion should demand, while it is not too much to say that no one has the slightest idea that the record speed will ever again be made in actual service. When an ocean liner already holds the record she usually makes efforts to break her own record, but if this sort of an attempt has ever been made by any of our crack cruisers we have yet to hear of it.

COMMENT was made in these columns several months ago, in discussing some points connected with the work of the bank and vault commission of the government, that the use of electric power by burglars might radically change the methods of attack, and the propriety of investigating this matter was suggested. It now appears that the work of the commission is to be supplemented by practical investigation of this matter, and the result will be awaited with interest. If electric power can be successfully applied for such purposes of destruction it may also be utilized for far more laudable service. It has long been held by the writer that, if all the money which has been spent in sporadic and disconnected Arctic explorations, for instance, had been applied to continuous and progressive gradual advances, each station being made permanent and serving as a base for the next season's progress, we should have wrested the secret of the pole from its ice-walled fortress long ago. An exploring party tied to headquarters, so to speak, by a string over which light, heat, and power could be sent on, could make most substantial advances, and could scarcely come to permanent grief if in constant communication with its base of supplies. In like manner not only Arctic explorations but all sorts of attacks upon nature can be vastly aided by the application of either stored or transmitted power, and the whole subject of the exploration of the yet almost unknown portions of the world assumes a new aspect. In Lord Lytton's fanciful romance, "The Coming Race," the tremendous progress of the people there described is said to be mainly due to the possession of a mysterious and portable form of stored energy which he named "vril," but it may be that its possession will be found merely in the application of means already within our hands, and the consequences of which at the present time can only be left to the imagination.

THE utilization of natural forces as sources of motive power has been much discussed and is constantly attracting more and more attention. Niagara is al-

ready passing into engineering history, and now the project for controlling the power of the tremendous northern current which sweeps down through the Irish channel is being seriously considered, the principal engineering feature in the plan consisting in the artificial contraction of the channel at the Mull of Cantyre, in order to obtain the necessary velocity. The whole question of the utilization of natural forces depends mainly upon the completeness of the solution of methods of long-distance transmission, and, these once perfected and losses reduced within practical limits, the rest will readily and promptly follow. Winds, tides, ocean currents, natural sources of heat, or differences of temperature even between widely-separated points,—all these and many others contain potentialities as yet scarcely appearing in the dreams of man, but they may be no further from realization than was the telegraph a hundred years ago, the telephone twenty years ago, or the flying machine—to-morrow?

THE subject of dimensioning drawings, concerning which we made some remarks several months ago, is being discussed to some extent in another direction, namely, as to the extent to which inches should be used before changing the notation to feet. There is no fixed practice in this respect, some drawing-offices expressing all dimensions in inches up to 36 inches, and then in feet and inches; others going as high as 48 inches; and still others no higher than 24 inches. There are various arguments for all these practices, but the best argument is that which best stands the test of daily use, and it certainly seems desirable to avoid the use of more than one unit whenever possible, unless loss of clearness is likely to result. In many cases the inch is used as a unit for still larger dimensions. In speaking of bicycle-wheels, for instance, no one would think of referring to a 54-inch wheel as 4 feet 6 inches in diameter, while with pulleys also the inch is used as far as conveniently practicable.

The metric system has yielded to this desire for simplicity to a large extent, and drawings made in that system are constantly seen with even large dimensions expressed in millimeters only, notwithstanding the provision of the centimeter and decimeter for the decimal multiples. The ease with which the introduction of the decimal point renders the transformation of units possible in the metric system of course makes this a very simple matter of choice, but, at the same time, there is much less liability to error by avoiding the use of two units, and the difference between 4′ 2″ and 42″ is not so great but that errors are apt to occur when the figures are hastily made and as hastily read. It is certainly unwise to base any practice upon either the yard or the 2-foot rule, as the yard never had any place in the machine-shop or drawing-room, and the 2-foot rule is a carpenter's stool, and, in these days of accurate shop-work, is now nearly or altogether superseded by the steel scale, the micrometer caliper, or the more accurate gages of modern practice. Uniformity in practice is certainly desirable, but at least let the inch be used as high as four feet. In the writer's opinion 72 inches is to be preferred to 6 feet and can be written in less space than the latter, when the notation "ft." is used, as indeed it always should be, if immunity from errors of confusion is to be insured.

MENTION has been made in these columns already more than once of the value of graphical methods of solving both mathematical and mechanical problems, but the subject is one which will bear constant attention, and no apology is needed for frequent discussions. It is not uncommon to hear men say that graphical diagrams will do very well for approximate results, but that the superior accuracy of calculations gives them marked superiority. It is doubtless true that results can be obtained by analytical methods to a far greater degree of refinement than is possible by the use of scale and dividers, but the sense of accuracy which is pleased with results carried out to the sixth decimal place is sometimes marred by the discovery that some important element in the calculation has been omitted, or, as is often the case, that it is impossible to use

the results thus laboriously obtained to a greater degree of precision than, say the second decimal place, and that the work which has been expended is unavailable.

As a matter of fact the graphical processes will give results which are nearly always as precise as any of the subsequent uses which are to be made of the values thus obtained, and it is of little use, for instance, to determine dimensions which, when obtained, are to be laid out on a drawing, to a closer value than can be read from a scale or marked with a pencil, so that for such purposes the same system is equally reliable for the one or for the other. At the same time, it is possible to use graphical methods to investigate subjects which are only solvable analytically by most tedious labor and that too by those who have kept themselves expert in this branch of work by close study and constant practice. The true end of mechanical engineering is the production of the completed and operative machine, and this itself is a drawing, executed in steel and iron, and the symbols which are but as a means to this end need never be more precise than their final outcome in any case.

AMONG the graphical methods which may be found most useful, apart from the well-known statical problems, may be cited the use of curves for the determination of a large number of values, for tabulating or transforming, for instance. By calculating a limited number of values and erecting these as ordinates a curve may be drawn from which all the intermediate values may be measured in a few moments and with an accuracy which is limited only by the scale of the diagram and the skill of the operator. In like manner many equations may be solved graphically by drawing the curve which includes the given conditions and obtaining the roots directly by measurement, when, if still greater precision is required, the substitution of these values will enable a first analytical approximation to be obtained with an ample degree of precision. A little experience will often suggest the best method to apply in any particular instance, and the growing increase in the use of such methods is ample evidence of the appreciation which is being given them by practical engineers.

AMONG the various branches of applied mechanism, the subject of lock-construction is one which has scarcely had the attention which its importance demands in technical literature. A fine lock is a piece of mechanism which requires for its construction not only the exercise of the highest degree of ingenuity, but also demands the best mechanical skill available in the domain of mechanical engineering. Nearly every other article of machine-construction is made for use only,—although of course everything has also to bear its share of abuse,—but a lock is made for the very purpose of standing ill treatment and is really only fully doing its work when it is resisting the efforts of some one to injure or force it.

As Reuleaux has well remarked of this branch of mechanism, "locks, in spite of their universal use and of the high order of inventive talent devoted to them, have had no analytical treatment, but have been relegated to the domain of technology rather by accident than otherwise." They undoubtedly belong where he has properly placed them, among the higher classes of ratchet-gearing, the combinations often reaching the second and third order even in ordinary locks, while the elaborate dial-locks, timelocks, and automatic devices reach into much higher orders of mechanism.

Probably one reason why this branch has received so little technical attention lies in the fact that, like watchmaking, the art of locksmithing was for a long time in the hands of isolated artisans, each adhering to his own traditions and holding aloof from his fellows. As this state of things passed away, the same close control of the subject continued with the larger manufacturers until the present time finds it undergoing the transformation into a product of the same scientific application of mechanical principles which has already controlled nearly every other branch of mechanical manufacture. To-day a lock is designed

with the same care and with the same fullness of detailed drawings as is a lathe or a steam-engine, and the strength of its parts proportioned not only to meet the operative forces but also the destructive efforts of the enemy. The mathematical principles of permutation and combination are carefully applied in order to obtain, with the greatest simplicity, the greatest number of key changes, while the theory and practice of masterkeying presents some of the most beautiful problems which the science of mechanism has to offer. Some day this branch of mechanism will demand a treatise worthy of its importance and the information at present contained in trade catalogues, note-books, and human memory will be placed upon record in a manner comparable with that of other and no more important mechanical subjects.

MR. ECKLEY B. COXE, in his admirable presidential address at the Montreal meeting of the American Society of Mechanical Engineers, brought out a point in engineering education which has been too often overlooked. In the demand to-day for specialists, the importance of a broad fundamental training is too often overlooked, and, in consequence, a specialist often finds that some unforeseen change in practice, brought about perhaps by some new invention or method, renders his special knowledge nearly valueless, from a commercial point of view. When, however, an engineer really possesses, in the sense of *owning*, a knowledge of the fundamental principles upon which every branch of his profession is based, he may devote himself to the practice of any special portion of its wide field without feeling himself at the mercy of any sudden change in practice or method. There is an anecdote told of a schoolboy who, when asked if he knew Greek and Latin, answered that he could hardly say that he *knew* them, but could say that he was *aware* of them. It is more than likely that many specialists in engineering are scarcely more than aware of the practice of any but their own limited branch of the profession, and it is such specialists who are first to feel the force of sudden changes and upheavals.

A USE of high-pressure water, primarily introduced for purposes of motive power only, has been found in some of the cities in England where this system has been introduced, which was hardly considered in its full value at first. By using a jet of high-pressure water from the power mains as an induction jet in an ejector pump, a powerful stream for fire-extinction is available almost anywhere where connections can be made. Double-injector hydrants connecting the high-pressure supply with the main water-pipe supply, have been furnished both in Manchester and in Hull, as well as in London, and in many cases have rendered good service with but moderate use of the high-pressure water. This system is decidedly more practical than that which has been discussed in the United States, namely, that of providing sufficient moderately high-pressure water supply for direct use; and the entire subject of fire-protection by some more scientific method than the present medieval system of horses, men, dogs, and general pandemonium, in order to get a machine of limited capacity and still more limited efficiency somewhere in the neighborhood of the fire, is a consummation which is most devoutly to be wished.

COMMENT & CRITICISM

The Situation in Peru.

IN the Magazine for July I was both surprised and pained to see a communication signed "N. J. S." on the subject, why is not Peru entered and developed by Americans? Your correspondent declares that "Catholicism is the answer," and then he insinuates that Catholicism is not Christianity.

I presume that if your correspondent is an engineer he will admit that it is the business of an engineer to deal with hard, cold facts, and not with theories born of prejudice; and to draw conclusions from a long series of observations taken from different points of view, and not pass snap judgment on such a question from observations to be made in "less than an hour" in the city of Lima. Again, let a man approach the natives of Lima or any other city with the feeling that they are socially, politically, and morally beneath him, that they are a deluded, priest-ridden community, and it is no wonder that they fail to appreciate him or bow down to his superior intelligence and make him a bosom friend.

The fact is that Lima is a well-laid-out city, having the oldest university in America, together with numerous schools, charitable institutions, and a public library. In a population of about 200,000 there are seventy churches,—certainly not a very priest-ridden showing. The high price of labor has hitherto prevented any efforts at manufacturing on a large scale being permanently successful. Chinese coolies are imported under contract for all railroad construction and other heavy work. Of course Lima is not New York or Boston, and a stranger speaking a foreign tongue naturally has an up-hill time of it in getting along with the natives. The country is just recovering from the effects of the war with Chile, and this, together with the general instability of the government in South American republics, causes outside capital to be very slow in making investments. The fact that among other public works the railway was constructed over the Andes with its numerous switchbacks, tunnels, and bridges, on one of the most elevated and most difficult locations in the world, would indicate that spectacular religion is not the principal business of the country, as your correspondent would have us believe. Also the fact that at the port of Callao over 2000 vessels arrive and depart annually, doing an annual business of over $30,000,000, would seem to point the same way.

An author who evidently took in the whole situation gives his conclusions as follows:

> We have no reason to believe that more than one acre in a hundred of maritime Peru will ever be available for the sustenance of mankind. The country has two advantages—its mines of the precious metals and a temperate and delightful climate. It can never be rich in the proper sense of the term, or make much progress in the improvements which depend upon a dense population. It has no navigable rivers, and nature has deprived it of the means of forming good roads. There are indeed few countries in the world whose natural advantages have been so much overrated as Peru; and it requires little sagacity to discover that its future career cannot correspond with its past celebrity. The districts east of the Andes, which have a hot climate accompanied with a rich soil, will ultimately be the most valuable part of the country.

While we all admit that this Yankee nation of ours contains the greatest "hustlers" in the world, yet, since we have copied the Australian ballot and the Swiss referendum and the Norwegian liquor-law, we may possibly discover something worthy of imitation in Peru, where they are not given up wholly to the worship of the almighty dollar, and where the worship of God is the rule rather than the exception, which we fear is the tendency in our own country.

J. T. D.

No Obstacle in Peru.

UNDER the caption "The Obstacle in Peru," there appeared in this department of the July ENGINEERING MAGAZINE such an unjust arraignment of the relation existing between the church of Peru and the civil life of the republic that I must claim in the name of truth a little space to set the matter right. Certainly the church of Peru contains little to excite the devotion or respect of intelligent men or women. It is tyrannical to the poor and humble, craven to the rich and powerful, and altogether a rotten mass of depravity. Its clergy are, with rare exceptions, drunken debauchees; its religious orders are also grossly immoral,—notoriously and publicly so. But nothing in all this horrible condition militates against the Protestant foreigner. So far is it from being true that "Religion is the supreme concern, and all business affairs are mere side-shows that get along the best way they can," the church has an exceedingly lax hold on any but the very ignorant. Even religious processions are prohibited on the streets of the capital, and the "feast days" of the church are simply excuses among all classes for frolicking and drunkenness. This vice and not the church keeps the carpenter from his work on Monday and interferes with the continuity of labor. But this result is the fault of the employer of labor as well as of his journeyman.

I have lived eight years in Peru, in constant charge of public works, and have at times had 1700 men employed, Peruvians and Chileans, all Catholics of the Spanish church. Even my immediate assistants have been of the same faith, and yet I have never experienced the difficulty your correspondent complains of. Indeed, the South Americans as a rule are less devoted to their church than were the Irish navvies of forty years ago in these United States. The educated men of Peru are agnostics, as are all the class in Spanish America. The church is a civil institution of the country, of which the officers, its clergy, are, like many other politicians, corrupt leeches fattening on the public blood. They are rarely admitted to good society, being generally recognized as unfit associates for the families of self-respecting husbands and fathers; but the ceremonies of the church invest with a certain dignity the bestowing of names on children, the solemnizing of marriage, and the final burial of the dead.

Beyond these affairs, not one man in a hundred ever troubles the church on other than patriotic occasions, when a mass of *gloria* or *requiem* is to be celebrated.

Americans and Englishmen are doing as well in Peru as they deserve to. They are admitted to as good society as they are allowed to enter at home. But, unhappily, the country has been visited by a multitude of American adventurers, whose ability in poker and whiskey obscures any other virtue they may happen to possess.

ALFRED F. SEARS.

New York, August 4, 1894.

A Correction and a Protest.

THE article of Mr. H. Guillaume, "Business Opportunities in Peru," in your June issue, conveys a mistaken impression as to the extension of the Central railroad. The distances and heights of the principal stations are as follows:

Dist. in miles.	Stations.	Heights in feet.
0.0	Callao	8.7
7 7	Lima	500 0
33.2	Chosica	2,800,6
47.1	San Bartolomé	4.959 4
63 6	Matucana	7,788.8
78.5	San Mateo	10,534 1
87.2	Chicla	12,215 5
106.1	Galera tunnel	15,665.2
136 5	Oroya	12,178 7

I cannot close these remarks without a protest against the article "The Obstacle in Peru," in the July number, by N. J. S., of Frankfort, Ky. Your correspondent was probably "plumped down in a balloon in Lima," and plumped up again, without time to form an opinion. I would appeal to the testimony of such persons as Messrs. Virgil P. Vogue, O. F. Nichols, Leffert L. Buck, Maxwell, and many, many others who have lived and worked in Peru for years, and who would be utterly surprised at the fancy picture drawn by N. J. S. (probably from stories of the Peru of Pizarro of the sixteenth century). E. C. ZEGARRA, C. E.

Piura, Peru, S. A., July, 1894.

[NOTE.—In view of the opposition which

the communication referred to has aroused, it becomes proper to say that N. J. S. is a professional gentlemen of the highest standing, well known to us, who spent several years in South America, and has since kept in touch with Peruvian and Chilean affairs through friends and acquaintances there, among them Americans closely identified with the business interests of Peru.—THE EDITOR.]

Photography of Working Drawings.

ON page 590 of the Magazine for July appears a note in regard to the reduction of working drawings by photography. I have found this method very convenient and have carried it still further by having a retracing made from the reduced print. On this are placed the figures and other data in such size as to be conveniently read, and prints from these in most cases, can serve all the uses of the larger blueprints. By judicious choice of scales, the essential points of several drawings can be incorporated in one 8′ × 10″ print, which is readily enclosed in an ordinary business envelop, yet contains sufficient matter for the assembly of machines, lay-out of foundations, or general information. The expense of the reduction is small, as the draughtsman can trace without lay-out everything except title and figures, and the fact that I am supplying several hundred of them per month in place of larger drawings is sufficient evidence of their practical value. F. G. PRATT.

Schenectady, N. Y., July 16, 1894.

Weight of Sand and Cement.

IN an article on cement and cement-testing in the Magazine for June, the weight of sand is said to be less than of cement of equal quantity by measure. By actual trial at the laboratory here we find the weight of a cubic foot of loose cement:

Pizzolau	57.4	Portland Cements.
Sphinx	73.2	
Dyckerhoff	76.5	
Alseus	68.0	
Average	68.8	

As an average of a number of experiments we find when sand and cement are taken loose as in laboratory testing, cement weighs 65 per cent. of weight of equal quantity of sand by measure. That is, 5 of sand to 1 of cement by weight is equivalent to 3.25 of sand to 1 of cement by measure, and 3 of sand to 1 of cement by weight is practically 2 to 1 by measure.

JAMES D. M'KEE.

Waterworks Extension, St. Louis, Mo., June 2, 1894.

CURRENT TECHNICAL LITERATURE

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. By Francis B. Crocker, Professor of Electrical Engineering, Columbia College, and Schuyler S. Wheeler, D. Sc., Electrical Expert of the Board of Electrical Control, New York City. With a special chapter by Horatio A. Foster. Second Edition, revised and enlarged. New York: D. Van Nostrand Co. [Cloth. 8vo. 205 p. $1.]

THE contents of the first edition of this book appeared first as a serial in the *Electrical Engineer* during 1891–92, its object being to give simple directions for the practical use and management of dynamos and motors. In the preface to that edition the authors stated that it was the design that the book should be simply the groundwork of a larger and more elaborate treatment of the same subject. How well this first edition met an already-created want was evidenced by its exhaustion in less than a year, and the present volume is the fulfilment of the promise then made. In this we find many additions which have largely increased the value of an already-valuable work. The chief of these are in the chapter on examination and testing of machines and the special instructions for handling the Thomson-Houston, Brush, and other arc-light machines.

The first of these additions has made the chapter on examination and testing so full as to entitle it to a department by itself and it now appears as Part II. The latter additions, which cover a class of machines not treated in the first edition, constitute Part IV.

This work is an eminently practical one on an eminently practical subject, and, as it is intended more especially for those who are not versed in electro-technics, has been couched in simple terms which all may understand.

Messrs. Crocker and Wheeler, aside from their responsible professional work, are also engaged in the extensive manufacture of motors, but they are regarded by the profession no less highly for their scientific achievements than for their work in the more practical line of manufacture into which they have brought to bear in a most practical way the teachings of advanced science. They therefore speak with an authority upon all subjects of which they write, which is recognized by every one, and their book would need no better introduction to the public than the weight of their own names. It has, however, had the further introduction of a first edition which has given it a prestige that even their personal reputations could not give.

Mr. Horatio A. Foster, who adds the chapter on the Thomson-Houston arc-dynamo, is also specially qualified to write on his subject. Mr. Foster, while connected with the Thomson-Houston Co., devoted his time exclusively to the study of the diseases and remedies of this peculiar though well-known machine, so that he is to-day probably the best authority on its management in this country.

With such sponsors it is not a surprise that the book is what it is, viz., by long odds the best that has thus far been published on the practical management of dynamos and motors. Part I is strictly elementary in character and deals with general principles at first, followed by chapters giving instructions on selecting dynamos and motors, circuits and windings, installing and belting machines, wiring and connections, and starting dynamos. Chapter VII is an extremely practical one, dealing with the various ways of switching dynamos of the different kinds into circuit. This chapter is fully illustrated with cuts which assist the text so that the reader cannot fail to understand the instructions given.

Not only are the direct-current machines —short, series, and compound—here treated, but also alternating-current machines. Chapter VIII is devoted to a description of the different types of motors and the

precautions necessary in starting the same. Chapter IX gives general directions for running dynamos and motors and as to personal safety and chapter X, which closes Part I, is devoted to precautions to be observed in stopping the machines.

Part II, which is devoted to "examination, measurement, and testing," gives in seven short chapters full instructions suitable for the dynamo-tender as to what to measure and how to measure it, together with brief descriptions of the instruments needed, with diagrams showing the proper connections when in use. This is the least satisfactory part of the book and necessarily so on account of the utter impossibility of compressing within 34 pages a treatise on electrical testing. The subject is admirably handled, however, considering the limitations in space which the authors have imposed upon themselves, but we would like to see in the next edition more space given to this subject.

Part III, on the localization and remedy of troubles in dynamos and motors, will undoubtedly be more widely appreciated than any other, as it appeals directly to those who are in trouble and who, when perplexed as to the cause of a difficulty, have no one to go to to ask instructions, or who must act immediately. It is not intended that these instructions, which are sometimes somewhat empirical, shall supplant, but rather that they shall supplement, a more intimate knowledge of dynamo-electric machinery. They are written, however, more particularly for the layman, but serve nevertheless as a ready reference for those better posted. The style is therefore that of the household medical book rather than that of the medical treatise. For instance, under "sparking at the commutator" we find fourteen separate causes—marked 1 cause, 2 cause, 3 cause, etc. Under each *cause* comes *symptom*, with a description by which the cause may be recognized, and this is followed by *remedy*, which gives simple instructions how the difficulty may be rectified.

There are eleven chapters in Part III, each of which is devoted to a different class of troubles, such as the one just referred to, heating of armature, motor stops or fails to start, dynamo fails to generate etc.

Part IV is devoted to dynamos and motors reqiring special directions and comprises: Chapter XXIX, Thomson-Houston arc-dynamo—setting up; Chapter XXX, the same—troubles and remedies; Chapter XXXI, Brush arc-dynamo; Chapter XXXII, Fort Wayne, Sperry and Excelsior arc-dynamos; and Chapter XXXIII, arc-motors.

It will thus be seen that the scope indicated by the title is quite fully carried out in the text, and, it may be further said, most admirably carried out. It has seldom been our pleasure to give a book the unqualified endorsement that we can and do give this one, and we heartily wish that this little brochure could be placed in every dynamo-tender's and motorman's hands, both on account of the assistance it would be to them and on account of the saving it would effect in wear and tear to the machinery through the increased intelligence with which it would be handled.

NELSON W. PERRY.

LES TRAVAUX PUBLICS ET LES MINES DANS LES TRADITIONS et les Superstitions de tous les Pays. By Paul Sébillot, Ancien Chef du Cabinet, du Personnel et du Secrétariat au Ministère des Travaux Publics. Paris: J. Rothschild.

IN these depressing days, when work for the engineer is at a premium, a work dealing, as this does, with the romantic side of engineering may well find acceptance. The author lays before his readers a wealth of information and of illustration arguing a vast deal of patient and painstaking labor, and forming, together, a volume of exceptional interest.

Devoting his first chapter to common roads, in treating of which he reproduces some excellent old prints of ancient Roman highways, the author passes on to the subject about which tradition and superstition seem to have chiefly exercised themselves: that of bridges. One is tempted to believe that St. Peter could hardly have had more churches than the devil has had bridges. It is curious how little originality is sometimes displayed by the framers of tradition. The old story in which the devil comes to the assistance of the

engineer distracted by the difficulties of the location of his bridge, offers his assistance, generally on condition of having for his own the first person who crosses the bridge, and then, like a gentleman, carries out his part of the contract by seeing the engineer through and the bridge completed, while the engineer, with an impudence that ought to shame the other party to the contract, puts him off with a dog or a cat,—this story seems to have done service in connection with each one of the innumerable "devil's bridges" scattered over Europe, the despair of the traveler desirous of visiting the veritable devil's bridge.

In this chapter the author shows excellent sketches of the Pont de Veille-Brioude, the Pont de Ceret, and the Ponts du Diable in Catalonia, over the Reuss, and at Lanza, but seems to have overlooked the great bridge which once spanned the Adda at Trezzo, in Italy, with its single arch, said to have had a span of some 250 feet, the remains of which are still standing.

As a matter of recent history, though it may not have been a case of superstition, the author mentions that at the laying of the corner-stone of the bridge over the Seine at Conflans, in 1890, in presence of M. Yves Guyot, minister of public works, it was discovered at the last moment that none of the assistants had about him a coin bearing the date of that year, and some delay was submitted to while search was made in the neighborhood for the desired article.

A practical point for the pile-driver is the belief attributed to the Japanese, that, if a pile be placed with its narrow end downward, the sprites inhabiting it, resenting the inversion, will take flight and the pile will at once decay.

If the steam railroad had been a growth of the middle ages, it would no doubt have given rise to a scheme of tradition and superstition, compared with which those that cluster about the bridge might hide their diminished heads. As it is, that comparatively modern invention forms the subject rather for caricature.

Under canals and lakes, as well as under mines, the divining rod, as might be expected in a work of this sort, plays a prominent part, and a number of excellent old cuts are reproduced, showing various methods of holding this uncanny instrument.

Our author, however, does not confine himself to the romance of engineering. Under the head of "harbors" is shown an interesting cut illustrating an ancient method of dredging. A grapple is placed in the stream, a little way out from shore, and connected with the shore by a rope, a few turns of which are taken around an upright pole which is stayed at the top by guys. The workmen then, turning the pole by means of horizontal levers, drag the grapple in toward shore, the grapple bringing with it the dredged material.

Under "mines," also, is shown an old cut from de Bry's "Voyages," illustrating the interior of a mine at Potosi, and particularly the leathern ladders in two parts or sides,—one for ascending and the other for descending.

Among the most interesting of the 413 excellent illustrations which alone would suffice to render this work one of unusual interest, is a series of views, reproduced from a print of the eighteenth century, showing the slate-quarries at Fumay. These are taken from the national library and have never before been published.

In addition to the cuts referred to there are given three colored plates and eight plates showing reproductions of medals. Both in its illustrations and in its press-work the book is a marvel of excellence.

NEW ROADS AND ROAD-LAWS IN THE UNITED STATES. By Roy Stone, Vice-President National League for Good Roads and United States Special Agent and Engineer for Road Inquiry, Department of Agriculture. New York: Van Nostrand [Cloth, 12mo, iv–166 pp. $1.50.]

THE general interest which has been awakened in the United States within the past few years in the subject of highway improvement is beginning to bear a considerable amount of fruit, both legislative and literary, and, what is even more to the purpose, work is actually in progress in some parts of the country under auspices which promise well for the future of this great national reform. Although not much can be said for either the literary or tech-

nical merit of the present treatise—and in fact it makes no pretensions to either—it nevertheless contains, in convenient and accessible form, a large amount of information which would otherwise have to be tediously sought for in scattered reports and ephemeral publications. The work comprises a compilation of extracts from these and other sources, giving a fairly complete account of the progress which has hitherto been made in road-improvement in different parts of the country, and a summary of road legislation, actual and prospective, in the various states. New Jersey and Massachusetts apparently have taken the initiative in this important matter, effective state aid being furnished in both cases, though under widely different provisions. In New Jersey work must be undertaken by the county authorities upon receipt of a petition of the owners of two-thirds the property fronting on the road, covering not less than one mile in length. One-third of the cost is defrayed by the state, one-tenth by the abutting owners, and the balance by the county and town. This law has been found to work admirably in practice, and an increasing length of roadway is being built under its provisions with each succeeding year. In Massachusetts the new roads are being built by the state under the supervision of the engineers of the state highway commission, the initiative being required to be taken, either by the county-commissioners or by the selectmen of a town, by petition to the commission. Upon the approval of the commission, not more than ten miles of state road may be built under petition in each county in each year, but the governor and council may in their discretion authorize this amount to be exceeded. One-fourth of the total amount expended in any county must be repaid to the state by that county within six years. According to advices received since the publication of this work more than 100 miles of improved road are to be constructed in Massachusetts before the close of the present year. Some of the best highways in the country, considering the small amount of money expended upon them (less than $1000 per mile), have been built in New York State under the provisions of the existing county-road law. It is pertinent, however, to remark that in this instance the supervisor appears to have been an engineer and not a hack politician. This book is handsomely illustrated with half-tone engravings, showing conspicuous examples both of good and bad roads, together with a number of working-drawings, illustrating modes of road-construction referred to in the text.

FRANKLIN L. POPE.

POPULAR LECTURES AND ADDRESSES. By SIR WILLIAM Thomson (Baron Kelvin), P. R. S., LL.D. D. C. L., Professor of Natural Philosophy in the University of Glasgow, and Fellow of St. Peter's College, Cambridge. Volume II—Geology and General Physics. London and New York: Macmillan. [Cloth. 8vo. 592 p. $2]

THIS is the last of three volumes, the first and third having preceded this in the order named. It consists of a compilation of the author's various papers relating to geological subjects and of lectures and addresses given by him between 1866 and the end of 1893, which were not included in Volumes I and III. While it thus contains nothing new, the many admirers of Lord Kelvin—and they are legion, for he is everywhere admitted to be the world's greatest living philosopher—will be glad to have these papers in handy form for reference and perusal. In treating of a work like this, criticism would be out of place and the reviewer will have done his work if he conveys to the mind of the reader a correct idea of the scope of the book. This can be best done by repeating the table of contents:

Polar Ice-Caps and their Influence in Changing Sea-Levels; On the Rate of a Clock or Chronometer as Influenced by the Mode of Suspension; On a New Astronomical Clock; On Beats of Imperfect Harmonies; On the Origin and Transformation of Motive Power; On the Sources of Energy in Nature Available to Man for the Production of Mechanical Effect; On the Dissipation of Energy; the Bangor Laboratories; Presidential Addresses; Address Delivered on the Occasion of the Unveiling of Joule's Statue in Manchester Town Hall, December 7, 1893; Isoperimetrical Problems; Protection of Vegetation from Cold; The Doctrine of Uniformity in Geology Briefly Refuted; Appendix

—Estimate of Present Annual Loss of Heat from the Earth; On Geological Time; Appendix—On the Observatories and Calculations Required to find the Tidal Retardation of the Earth's Rotation; On Geological Dynamics—Part I, Reply to Professor Huxley's Address to the Geological Society of London, February 19, 1869. Part II, On the Origin and Total Amount of Plutonic Energy. Part III, Note on the Meteoric Theory of the Sun's Heat; Presidential Address to the British Association, Edinburgh, 1871; Presidential Address to the Society of Telegraph Engineers, 1874; Review of Evidence Regarding the Physical Condition of the Earth; Geological Climate; The Internal Condition of the Earth as to Temperature, Fluidity and Rigidity.

This catalogue of important papers cannot fail to be of interest, in some of its numbers at least, to a large circle of readers, and they will find the text clear and heavily leaded, so as to be read without physical fatigue. The three volumes of which this is the second is the last addition to the "Nature Series."

THE USES OF COMPRESSED AIR. By ADDISON C. RAND. Illustrated. New York: The Republic Press. [Cloth. 12mo. 134 p. $1.]

EVEN those who have closely watched the wonderful development of compressed-air systems will be surprised at the array of successful and important utilizations described by Mr. Rand. A simple enumeration of these uses would make a long list, but among the more prominent ones described are those of tunneling and mining by power drills, working and drilling in caissons, tapping iron-furnaces, the air-lift pumping system, air-brakes, operation of railway switches and signals, air-locomotives, street-cars, unloading cars, cranes, cutters and riveters, portable air-tools, synchronous clocks, coal-mining machines, air-guns, torpedo-guns, locomotive-torpedoes, transportation tubes, aërating fuel (petroleum, etc.), aërating water, refining asphalt, increasing the brilliancy of lamps, mixing nitroglycerin, pumping acids, etc., conveyance of sewage, raising sunken vessels, ice-making and refrigerating, pneumatic tires, general transmission of power, and so on, not forgetting the novel air-brush for painting large surfaces, which attracted so much attention during the preparatory stages of the World's Fair buildings. Mr. Rand presents the subject in an attractive, popular way. The book is attractively gotten up, with numerous and striking photo-engravings.

PRACTICAL INSTRUCTIONS IN QUANTITATIVE ASSAYING with the Blowpipe. Containing also readily applied Qualitative Blowpipe Tests. For the Prospector, Miner, and Assayer, and for use in Colleges. By E. L. Fletcher, U. S. A. New York: John Wiley & Sons. [Cloth. 12mo. 142 p.]

MORE can be accomplished with the blowpipe in the quantitative way than is generally supposed; and, while there are thousands who understand the use of the blowpipe for making qualitative determinations, there are few who appreciate its capacity for quantitative assaying. A practical, simple, and cheap work like this is something that has long been in demand. The author introduces some new methods, which he recommends as more certain than those usually taught. By his system a large quantity of ore is operated upon, so that the outcome does not depend so much upon the skill, or want of skill, of the assayer. Wet methods are omitted. As the author justly says, they to a great extent destroy some of the distinguishing merits of the blowpipe—its quickness and simplicity.

THE MONEY OF THE UNITED STATES. By MAURICE G. Muhleman, Cashier United States Sub-Treasury, New York: The *Safety Valve*. [Pamphlet. 70 p.]

THIS work contains an account of the money of the United States, which will be found a valuable compendium to those who have occasion to post themselves (1) upon legislative history of the various coins the and currencies of our country; (2) the volume of money annually from 1873, the year in which the coinage system was reorganized, to 1893; and (3) the leading propositions submitted in congress and elsewhere for the solution of the currency problem.

A STUDY OF THE MONEY QUESTION. By HUGO BILGRAM. New York: Humboldt Publishing Co.

THE author of this little book is a wide reader on economic subjects, and a close reasoner. He enjoys the distinction, too, among the men clamorous for more money.

of not believing in the vagaries of fiat money and other heresies of his school. When claiming the expediency of federal control over all the issues of money he has the good sense, also, to place it among the police- or commerce-regulating powers of the government. As to his theory, he seems to propose merely that all issues of money shall be convertible, not upon demand, but upon a time-limit protected by insurance, thereby creating a larger volume of what he calls credit-money. Well, this might work, too, but of what use would it be? We have more money now than we know how to use. Say that there are 20,000,000 persons in the United States,—which there are not,—on weekly wages or salaries to be paid every Saturday night. Say, also, that the average income of these persons is $3 a day, which it is not again, and it would take $360,000,000 for use each Saturday. But all this money returns to the banks again during the week following through the various channels of commerce and might be used fifty-two times in a year for the same purpose. As to the money passing between merchants, or between merchants and manufacturers, it is only used, as every one knows, in the settlement of balances. This method of estimating, and not foolish estimates on per capita circulation, is the way to find the amount of money needed. It is a merely mechanical question. England does a much larger commercial business than France with only about one-third the money that France uses.

We do not need more money, but we do need a more flexible currency, better protected in the machinery for its distribution. When depression comes, money begins to flow away from the extremities and to seek the financial centers, and panic finally develops a clear case of congestion. But no increase in the amount of federal currency would check this tendency. The remedy must be found in decentralization, in the local power of issuing money secured on local property. Hence the demand for the repeal of the state-bank tax, caused by the prevailing financial disasters.

WILLIAM NELSON BLACK.

NEW BOOKS OF THE MONTH.

Practical Electrics.=A universal handy-book on every-day electrical matters. New York: Spon & Chamberlain. [Cloth. 8vo. 3-135 p. 75 cents.]

Preston, T.=The Theory of Heat. New York: Macmillan. [Cloth. 8vo. 719 p. $5.50, net.]

Revill, Alfred.=American Plumbing. For master plumbers, architects, builders, apprentices, and house-holders. A complete compendium of practical plumbing, from solder-making to high class open work. Illustrated. New York: Excelsior Publishing House. [Cloth. 12mo. 255 p. $2.]

Rigg, Arthur.=A Practical Treatise on the Steam-Engine. Illustrated. Second edition. New York: Spon & Chamberlain. [Cloth. 24 = 379 p. $10.]

Rigg, A., *and* Garvie, J.=Modern Guns and Smokeless Powder. Influence of modern explosives upon modern guns. New York: Spon & Chamberlain. [Paper. 8vo. 83 p. $2.]

Rosewater, Frank.=A Romance of Utopia. A solution of the labor problem. Omaha, Neb. [Paper. 8vo. 268 p. 50 cents.]

Salomons, Sir David.=Electric Light Installations. Vol. II—Apparatus: a practical handbook. Seventh edition. Illustrated. New York: Van Nostrand. [Cloth. 12mo. 16-318 p. $2.25.]

Schaffle, A.=The Theory and Policy of Labor Protection. Edited by A. C. Morant. New York: Scribner. [Cloth. 12mo. 252 p. $1.]

Seligman, Edwin R. A.=Progressive Taxation in Theory and Practice. Baltimore, Md.: American Economic Association. [Paper. 8vo. 222 p. $1.]

Sheffield, O. H.=Improvement of the Road System of Georgia. (Bulletin No. 3, Office of Road Inquiry, United States Department of Agriculture.) Washington: Government Printing Office. [Paper. 8vo. 31 p. no price.]

Stone, Roy.=New Roads and Road Laws in the United States. New York: Van Nostrand. [Cloth. 12mo. 7-166 p. $1.50.]

Thompson, Langdon S.=Educational and Industrial System of Drawing. Illustrated. Boston: D. C. Heath & Co. [Seven series. Paper. 8vo. 25 to 60 cents, *each*.]

Waring, George E., Jr.=Modern Methods of Sewage Disposal for Towns, Public Institutions and Isolated Houses. New York: Van Nostrand. [Cloth. 12mo. 6-252 p. $2.]

Webb, Sidney *and* Beatrice.=The History of Trade-Unionism. New York: Longmans, Green & Co. [Cloth. 8vo. 16-558 p. $5.]

World's Columbian Exposition.=Official Illustrated Publication. Art and Architecture, in Thirty Parts, by William Walton. Philadelphia: George Barrie. [Folio, $1 per part.]

Young, Francis Chilton, *editor*.=Electrical Apparatus for Amateurs. New York: Ward, Locke, & Bowden, Limited. [Cloth. 8vo. 104 p. 40 cents.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturer.

The Dayton Globe Iron Works Co., Dayton, Ohio.=Power-Transmitting Machinery. 105-iv, p. [Contains in addition to the price-lists and illustrations, rules for calculating size and speed of pulleys, descriptive tables of gearing, journal-boxes, hangers, etc. It bears evidence of care in compilation, and will prove of value to those interested.]

Farrel Foundry and Machine Company, Ansonia, Conn.=Ore- and Rock-Crushing Machinery. 34 p. [Illustrations and descriptive matter of ore- and stone-crushers, crushing-rolls, mortar-mills, together with sectional views of ore-crushing and washing plants concisely described.]

H. W. Caldwell & Son Company, Chicago.=Elevating, Conveying and Power-Transmitting Machinery. 186 p. [An exhaustive publication descriptive of specialties made.]

Gifford Brothers, Hudson, N. Y.=Founders and Machinists. 40 p. [Contains in concise form description and price-lists of couplings, shaftings, friction clutches, etc., also tables and rules for determining horse-power of pulleys and engines.]

J. S. Mundy, Newark, N. J.=Hoisting, Bridge-Erecting, Pile-Driving, Logging and Mining Engines, etc. 72 p. [A carefully prepared catalogue setting forth the merits of the products of this well-known firm.]

Westinghouse Electric and Manufacturing Company, Pittsburgh.=The Wurts Non Arcing Railway Lightning Arrester, with practical hints on means for protection against lightning. 45 p. [A brief description of the discovery of non-arcing metal, together with a statement of the fundamental principles underlying its application. The hints contained are timely and practical, and aside from its value, the publication is a typographical gem.]

Interior Conduit and Insulation Company, New York.=Lundell Dynamos and Motors. 24 p. [Description of the Lundell dynamos and motors, with rules for their installation and use.]

The Cincinnati Corrugating Co., Cincinnati.=Corrugated roofing, corrugated lath, metallic weather boards, etc. 63 p. [Full description of the various products of the company with instructions as to use and rules for estimating quantities.]

Jenkins Brothers, New York.=Trade catalogue of valves, packing, etc. 68 p. [Contains full descriptions with price-lists, tables of dimensions, etc.]

A. Weiskittel & Son, Baltimore, Md.=Fire King Gas Stoves and Ranges, 51 p. [Descriptive of gas stoves and ranges, with an argument for the use of gas as fuel.]

Jarecki Manufacturing Company, Limited, Erie, Pa.=Malleable Cast Iron Fittings, Valves, Cocks, etc. 300 p. [Comprehensive descriptive catalogue of products manufactured, carefully compiled and indexed.]

Knowles Steam Pump Works, New York.=Power Pumps for Paper and Pulp Mills. 31 p. [A special publication descriptive of machinery for paper-manufacturers.]

The Westinghouse Air-Brake Co., Pittsburgh.=The Westinghouse Automatic Air-Brake. 78 p. [Modern brake appliances fully described, with copious illustrations. A handsome trade publication designed mainly for use of railway employés who have occasion to order air-brake supplies.]

Smith & Anthony Company, Boston, Mass.=Sanitas Plumbing Appliances. 64 p. [Complete and handsome catalogue of plumbing appliances, valuable to those interested.]

American Fuel Economizer and Engineering Company, New York.=Heating and Purifying Feed Water. 37 p. [Descriptions of fuel economizers, with suggestions for their care and arrangement; also useful data for engineers and steam-users.]

H. E. Olbrich, Cedar Falls, Ia.=Keplogle's Electric Regulators. 15 p. [General description of electric regulators for water-power users.]

The Hornberger Electric Manufacturing Company, Elkhart, Ind.=The Elkhart Transformer, Tooth Type.

American Saw Company, Trenton, N. J.=Saws and Saw-makers' Tools. 35 p. [Full description of various articles in the sawmakers' line.]

C. M. Kemp Manufacturing Company, Baltimore, Md.=The Climax Gas Machine and Gas Mixer. 48 p. [Descriptive of Gas-machines, mixers, and kindred apparatus.]

Miamisburg Electric Company, Miamisburg, Ohio.=Imperial dry battery and Burnley Cartridge Battery.

Henry Maurer & Son, New York.=Fire-Proof Building Materials. [Fully descriptive of materials, with illustrations of prominent buildings constructed.]

Kansas City Metal Roofing and Corrugating Company, Kansas City, Mo.=Corrugated Iron, Metal Shingles, etc. 32 p.

Rumsey & Co., Limited, Seneca Falls, N. Y.=Hydraulic and Pumping Machinery. 171 p. [Forty-ninth edition. Comprehensive publication containing descriptions of various hand and power pumps, hydraulic machinery, etc., manufactured.]

American Tube Works Company, Boston, Mass.=Brass Pipe. 32 p. [Of special interest to builders and plumbers.]

Rue Manufacturing Company, Philadelphia.=Injectors, Ejectors, and other Jet Apparatus. 16 p. [Descriptive price-lists of boiler-washing and testing apparatus, injectors, steam-valves, and kindred appliances.]

Gisholt Machine Company, Madison, Wis.=Modern Turret Lathe Practice. May edition; issued monthly. [Contains description of turret lathe machine work which will prove of interest to those concerned.]

[*For additional catalogues see "Improved Machinery," page 28 b.*]

THE TECHNICAL INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNAL OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves*. The unparalleled convenience and economy of this double service can readily be appreciated.

IN ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents, excepting those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents—according to the price of the publication quoted. All orders *must* be accompanied by cash or stamps.

To avoid frequent remittances and to cheapen the cost of articles to those who order largely, we sell coupons at the rate of 15 cents each, or 15 for $2, 40 for $5, and 100 for $12.50. Each coupon is receivable in exchange for one 15-cent article; those marked * require two coupons, and those marked † require three coupons. This system is strongly commended. The coupons need only a trial to demonstrate their great convenience and economy of time and money.

[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An....American Analyst. *f.* $1. New York.
A Ar....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W...Builder and Woodworker. *m.* $3. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $2. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng.....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E & R ...Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .....Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R.....Good Roads. *m.* $2. New York.

I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A.... ..Journal of Architecture. *m.* $2. Phila.
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20045. Rules and Regulations for Electric Lighting Steamships. Rankin Kennedy. (E R L-Began Feb. 16—2 parts to date—30 cts. each).

20247. The Nottingham Municipal Electricity Works. Ill. (E E L-Began Feb. 23—1 part to date—30 cts).

GAS ENGINEERING.

19647. Gas Combustion and Temperatures. J. P. G. (A G L J-Feb. 12.) 1000 w.

*19721. Gas as a Sanatarian. (Abstract.) Lynn Cyril D'Oyle (G W-Feb. 3.) 4400 w.

*19772. The Coal Elevating and Conveying Machinery at the Elland Gas Works. (J G L-Feb. 6) 1000 w.

19781. The East River Gas Undertaking, with Editorial. Ill. (P A-Feb. 15.) 12000 w.

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*20008. The Gas Supply of Manchester. J. W. Southern (G E M-Feb. 10.) 1000 w.

*20009. Donkin on Internal Combustion Motors. (J G L-Feb. 13.) 1700 w.

*20144. Inaugural Address of H. Smythe. (J G L-Feb. 20.) 4800 w.

*20145. Inaugural Address of R. O. Patterson (J G L-Feb. 20.) 3800 w.

20205. Advantages of a Combined Coal and Water Gas Plant, with Discussion. C. J. R. Humphreys (A G L J-March 5.) 7200 w.

*20231. Artificial Illumination (I C B-Feb. 23.) 2000 w.

*20345. Is a New Gas Undertakings Association Desirable? (J G L-Feb. 27.) 2000 w.

*20346. A New Method of Valuing Illuminating Gas. John T. Sheard (J G L-Feb. 27.) 1700 w.

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13534. The Gas Engine. Ill. (M W-Began June 2, 1893—7 parts to date—30 cts. each).

19650. The Chemical Technology of Coal Gas. Vivian B. Lewes (J G L-Began Jan. 30—5 parts to date—30 cts. each).

19815. Gas for the Household. William Paul Gerhard (D E-Began Feb.—1 part to date—30 cts).

20143. The Action of Heat upon Ethylene. Vivian B. Lewes (J G L-Began Feb. 20—2 parts to date—30 cts. each).

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*19636. Experiments on Two Forms of Hydraulic Rams. Ill. R. C. Carpenter (E M-Feb.) 400 w.

19770. The South Yuba Water Company. Ill. (M S P-Feb. 10.) 2200 w.

*19801. Storage Capacity in Lakes and Reservoirs. Ill. Elon Huntington Hooker (S J E-Feb.) 2500 w.

*19864. The Cost of Water Power. Editorial (I & I-Feb. 9.) 600 w.

19962. Water Tube Boilers for the St. Louis Water Works (E N-Feb. 22.) 1450 w.

19963. Driven Wells on the Plainfield Water Supply System. (Abstract) Louis L. Tribus (E N-Feb. 22.) 1000 w.

20012. Filter at the Wannacomet Water-Works, Nantucket, Mass. Ill. (E. R-Feb. 24.) 1200 w.

*20067. Storage Reservoirs on the Nile. Editorial (E-Feb. 16.) 2800 w.

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*20281. The Berry Tangential Water Wheel Buckets. Ill. A. E. Chodzko (I S F-March.) 1400 w.

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20353. The Lowell Water System. Ill. (F W. March 10.) 2500 w.

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*19811. Bleach and Caustic by Electrolysis (C T J-Feb. 10.) 1800 w.

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20341. Ontario Mines in 1893 (E M J–March 10.) 1300 w.

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18580. The Durham Coalfield. Ill. M. E. (C G–Began Dec. 22—6 parts to date—30 cts. each).

18640. Hydraulic Mining. Ill. Henry De Groot (M S P–Began Dec. 30—Ended Feb. 24 —8 parts—15 cts. each).

19079. Talks on Quarrying. Edward H. Williams, Jr. (S–Began Jan.—2 parts to date—30 cts. each).

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20223. The Cumberland Coalfield. M. E. (C G-Began Feb. 23—1 part to date—30 cts).

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21057. The Capital City Water Co. Case. Fred Crosby (F W-April 7.) 2800 w.

Serials.

18676. The Pumping Engine: Its Many Points, Faults and Peculiarities. Ill. Ernest W. Naylor (F W-Began Jan. 6—11 parts to date—15 cts. each).

18801. Discharge of Sluices and Weirs under Varying Heads. Ill. G. C. Maconchy (I E-Began Dec. 9—6 parts to date—45 cts. each).

20126. The Water Supplies in the Arid Regions. J. W. Powell (M S P-Began Feb. 24—3 parts to date—15 cts. each).

20808. Ahmedabad Water-Works Report. Ill. (I E-Began Feb. 24—2 parts to date—45 cts. each).

21015. Stand-Pipe Accidents and Failures. William D. Pence (E N-Began April 5—1 part to date—15 cts).

21021. The Missouri River. O. B. Gunn (R G-Began April 6—1 part to date—15 cts).

INDUSTRIAL CHEMISTRY.

*20571. Refrigerating Apparatus, with Discussion. Ill. Carl Linde (J S A-March 9) 6000 w.

†21025. The River, Well and Spring Waters of McKeesport, Pa., and Vicinity—with Discussion (E S W P-Jan.) 2000 w.

21095. The Reduction of Aluminum as a Scientific Problem. Alfred H. Bucherer (E M J-April 7.) 2700 w.

Serials.

15176. The Chemical and Physical Examination of Portland Cement. Ill. Thomas B. Stillman (J A C S-Began April, 1893—2 parts to date—45 cts. each).

17576. Theoretical and Practical Ammonia Refrigeration. Iltyd I. Redwood (Eng-Began Nov. 25—10 parts to date—15 cts. each).

INDUSTRIAL SOCIOLOGY.

*20446. Some Labor Questions. Editorial (Eng L-March 2.) 1600 w.

†20478. The Impending Revolution. Goldwin Smith (N C-March.) 6500 w.

20528. Brothers in Distress. A. B. Salom (I I G-March.) 1200 w.

†20532. The Rate of Profits under the Law of Labor Value. Isaac A. Hourwich (J P E-March.) 6000 w.

†20537. Work for the Workless. Arthur Withy (W R-March.) 4000 w.

†20635. Trusts Their Own Corrective. George A. Rich (P S M-April.) 1800 w.

†20640. The Unemployed. Editorial (P S M-April.) 2000 w.

20701.—$1. The Relation of Taxation to Monopolies. Emory R. Johnson (An A A-March.) 8500 w.

20702.—$1. I. The Farmers Movement. C. S. Walker. II. The Grange and the Co-operative Enterprises in New England. Florence J. Foster (An A A-March.) 8500 w.

*20708. Employers and Employed. Editorial (E-March 16.) 1100 w.

*20949. The Economy of High Wages. (Abstract.) George Gunton (S Ec-April.) 2200 w.

*21105. The Royal Commission on Labor. Editorial (I & I-March 30.) 900 w.

*21120. The Panic of Labor. Editorial (N B-April.) 1300 w.

21144. Some History in Figures. Editorial (A S-April 7.) 650 w.

LANDSCAPE ENGINEERING.

Serials.

19346. Public Squares. Ill. T. M. Newton (A A-Began Feb. 3—Ended March 24—5 parts—15 cts. each).

MARINE ENGINEERING

*20365. The Kite as a Life-Saver at Sea. Ill. J. Woodbridge Davis (E Mag-May.) 3000 w.

*20427. The Principal Harbor at Natal. Ill. (Tr-March 2.) 3000 w.

*20455. The "Baird-Thompson" Improved System of Ship Ventilation. Ill. (S L-March.) 900 w.

20459. Some Points on Lake Navigation. J. J. Brice (M R C-March 8.) 1100 w.

20503. Details of Electric Light Buoying, as Conducted under Direction of Captain Schley (Sea-March 15.) 1200 w.

20504. The First American Steel Sailing Ship.—The Dirigo. Ill. (Am S-March 15.) 900 w.

*20589. Large Ships of Cellular Type.—A New System of Construction. Ill. William Bell (E G-March.) 4000 w.

*20590. A Launch Near the Moon (E G-March.) 1500 w.

20591. Water-Tube Boilers—With Particular Reference to Experience with Generators of the Belleville Type (M R C-March 15.) 1700 w.

*20592. The Future of American Shipping and Ship Building (Tr-March 9.) 2000 w.

*20615. Waterways in America. Editorial (E-March 9) 1200 w.

*20696. Life Under Water. Ill. Gustav Kobbé (Sc M-April.) 4500 w.

*20697. A Winter Journey Up the Coast of Norway. Ill. Rasmus P. Anderson (Sc M-April.) 4500 w.

†20794. Our Navigation Laws. Charles H. Cramp (N A R-April.) 5200 w.

20871. Under the Cross of St. Andrew. Ill. V. Gribayédoff (Cos-April.) 4000 w.

*20897. Further Developments in the Atlantic Race. Editorial (I & I-March 23.) 600 w.

*20920. The British Seas (Tr-March 23.) 2000 w.

*20928. A Lightship Electrically Connected with the Shore (C G-March 22.) 1200 w.

*20931. On Circulation in the Thornycroft Water-Tube Boiler. (Abstract.) J. I. Thornycroft (Eng L-March 23.) 1800 w.

*20932. On the Comparative Merits of Cylindrical and Water-Tube Boilers for Ocean Steamships.—With Discussion. (Abstract.) Mr. Howden (Eng L-March 23.) 4500 w.

*20935. On Water-Tube Boilers. Ill. J. T. Milton (Eng L-March 23.) 4000 w.

20946. Amended Steamboat Rules and Regulations of the Steamboat Inspection Service (Eng-March 31.) 5000 w.

21051. The Coast Survey. John Ritchie, Jr. (B C-April 7.) 1600 w.

21094. Insurance Tariffs for Wood and Iron Hulls (M R C-April 5.) 2000 w.

*21100. The Vibrations of Steamers. Ill. Otto Schlick (Eng L-March 30.) 5500 w.

*21102. The Movement in Shipbuilding. Editorial (Eng L-March 30.) 1500 w.

*21128. A Model Canadian Port Tr-March 30.) 800 w.

Serials

16636. Marine Engine Design (M W-Began Oct. 6—6 parts to date—30 cts. each).

19094. On Piratical Seas.—A Merchant's Voyages to the West Indies in 1805. Peter A. Grotjan (Sc M-Began Feb.—Ended April—3 parts—30 cts. each).

20142. The Resistance of Ships. Richard Lano Newman (J F I-Began March—Ended April—2 parts—45 cts. each).

20217. The Belgian Government Mail Steamer "Marie Henriette." Ill. (E-Began Feb. 23—Ended March 9—2 parts—30 cts. each).

20679. Criticism on Mr. Carlile's Article on "Water Tube Marine Boilers." E. E. Roberts (Am S-Began March 22—3 parts to date—15 cts. each).

20945. Origin and Development of Steam Navigation (Eng-Began March 31—1 part to date—15 cts).

MECHANICAL ENGINEERING.

*20432. The Curved Arms of Pulleys. Ill. (M W-March 2.) 600 w.

*20436. On Automatic Adjustments for Bearings. Ill. W. A. M'William (M W-March 2.) 1500 w.

20489. Experiment and Experience. B. F. Spalding (A M-March 15.) 2200 w.

†20494. A Machine for Curing India-Rubber Sap. Ill. M. F. Sesselberg (I R W-March 15.) 1200 w.

20519. The Power Absorbed by a 56-in. Circular Saw. Ill. Robert C. H. Heck and Henry B. Evans (E N-March 15.) 2800 w.

20660. The Emery Testing Machine. Ill. J. Sellers Bancroft (A M-March 22.) 6800 w.

20672. A Method for Calculating the Stresses in the Ferris Wheel. J. W. Schaub (E N-March 22.) 300 w.

20678. Edison's Kinetograph (M S P-March 17.) 750 w.

*20714. Has Farm Machinery Destroyed Farm Life? E. V. Smalley (F-April.) 4000 w.

*20757. The Castle in the Air. The Aerial Castle at the Antwerp Exhibition. Ill. (M-March 15.) 250 w.

*20798. Balancing Pulleys (M W-March 23.) 1200 w.

*20799. Motor Cycles. William Fletcher (P Eng-March 23.) 1800 w.

*20803. The Schiele Curve and the Friction of Thrust Bearings. Ill. R. E. Horton (A M-March 29.) 1600 w.

*20902. Hoisting Machinery. J. H. Allen (I C B-March 23.) 900 w.

20975. Some Recent Air Compressors. Ill. (S M-April 1.) 600 w.

20996. Making a Fusee or Derrick Barrel. Ill. Joseph Horner (A M-April 5.) 1800 w.

*21006. The Laws of Friction. R. James Abernathey (I S F-April.) 1100 w.

†21027. The Edson Recording Gauge. Ill. (J F I-April.) 1000 w.

†21028. Notes on the Design of Gear Wheels. Ill. L. F. Roudinella (J F I-April.) 2500 w.

*21114. On Making Joints (M W-March 30.) 1500 w.

*21130. The Band Saw (I C B-March 30.) 2500 w.

*21137. A New Arrangement of the Ordinary Siemens Valve. F. W. Paul (I C T-March 30.) 1900 w.

Serials.

16781. Rope Driving. J. J. Flather (E W-Began Oct. 21—10 parts to date—15 cts. each).

17117. English and American Testing Machines. Ill. (E Rev—Began Oct. 20—Ended March 20—3 parts—30 cts. each).

17362. Arithmetic of the Screw and of Symmetrical Rings. Leicester Allen (A M-Began Nov. 16—3 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El-Began Dec. 1—10 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrech von Ihering (E M-Began Feb.—2 parts to date—30 cts. each).

19802. Mechanical Refrigeration. Ill. R. C. Carpenter (S J E-Began Feb.—2 parts to date—30 cts. each).

20580. Slide Rules and Calculations. Ill. (I C B-Began March 9—3 parts to date—30 cts. each.)

20750. A New System of Wheel Construction. Ill. Archibald Sharp (P Eng-Began March 16—3 parts to date—30 cts. each).

20900. Mechanical Drawing. Elementary Hints for Shop Men (T-Began April 1—1 part to date—15 cts).

21115. On an Overhead Power Travelling Crane. Ill. George Russell (M W-Began March 30—1 part to date—30 cts).

METALLURGY.

20380.—$1.50. A Proposed Method of Testing Structural Steel—Discussion on paper by Alfred E. Hunt (T C E-Dec.) 5600 w.

20381.—$1.50 The Use of Mild Steel—Discussion on paper by C. Weyrich (T C E-Dec.) 1700 w.

*20389. Forging by Hydraulic Pressure. (Abstract.) R. H. Tweddle (I & I-March 2.) 2000 w.

*20420. Blanzy Modifications in Appolt Coke Ovens. M. Marle (C G-March 2.) 2200 w.

*20464. Magnetism and the Makers of Iron. Sydney Evershed (El-March 2.) 1000 w.

*20465. On Methods of Testing the Magnetic Qualities of Iron—Discussion and editorial. Gisbert Kapp (El-March 2.) 7500 w.

†20467. A Plant for Granula ing Slag. Richard H. Terhune (S M Q-Jan.) 800 w.

20499. The Sebenius Rotator for Steel Ingots. Ill. (Ir Age-March 15.) 1350 w.

*20561. Iron Ores and What We Pay for Them. Walter J. May (C G-March 9) 1400 w.

*20570. Goldsmiths' Work : Past and Present, with discussion. Mrs. Philip Newman (J S A-March 9.) 7400 w.

20630. The Cost of Billets and of Rails (B I S-March 21.) 700 w.

*20643. The MacArthur Forrest Cyanide Process in Australia and South Africa (A M S-Jan. 27.) 1300 w.

20658. Comparative Density of Solid and Fluid Iron. I. McKim Chase (A M-March 22.) 650 w.

20661. Manganese in Foundry Iron. A. P. Bjerregaard (Ir Age-March 22.) 1100 w.

20662. Uniformity in Testing. P. Kreuzpointner (Ir Age-March 22) 1700 w.

20677. Colorado Gold Mill Practice. Henry Vezin's Contribution to the Discussion of T. A. Rickard's paper on "Limitations of the Gold Stamp Mill" (M S P-March 17.) 800 w.

20717. Concentration of Copper Ores on Lake Superior. (Extract.) Ill. Fred Fraley Sharpless (A M & I W-March 23.) 2200 w.

*20752. Ore-Washer at Longdale, Virginia. Ill. Guy R. Johnson (C G-March 16.) 1200 w.

20783. Mold-Drying Apparatus. Ill. S. Groves (F D-March.) 600 w.

20784. The Feeding Rod. Ill. H. Hansen (F D-March.) 2000 w.

20807. The F. L. Bartlett Zinc-Lead Process. (Abstract.) E. W. Hawker (M S P-March 24.) 900 w.

20830. Influence of Silicon, Sulphur and Manganese on Foundry Irons. J. B. Nau (Ir Age-March 29.) 4000 w.

20831. Cupola Heat and Quality of Cast Iron. W. J. Keep (Ir Age-March 29.) 1700 w.

*20853. Some Experiments in Hardening and Annealing Steel. W. G. V. Lottes (L E April.) 1800 w.

20867. The Principal Smelting Reactions of Blast Furnace Slag, Considered on Thermo-Chemical Principles. A. D. Elbers (E M J-March 31.) 2500 w.

*20883. On the Carbon Reactions in the Blast Furnace. William John Hudson (I & S-March 24.) 7000 w.

20899. The Rusting of Iron and Steel (M G-March 31.) 800 w.

20947. Utilizing Sand Ores for Furnace Work. Walter J. May (A M & I W-March 30.) 1100 w.

20977. The Colors Produced During the Tempering of Steel. Thomas Turner (S M-April 1.) 1650 w.

*21111. The Eight Hours Day in the Iron and Engineering Trades (C G-March 30.) 1700 w.

*21136. The Estimation of Manganese in Minerals and Metals. (Abstract.) E. H. Saniter (I C T-March 30.) 2000 w.

*21138. Packing Iron and Steel Goods for Export (I C T-March 30.) 1600 w.

*21139. Bauxite (I & S-March 31.) 1000 w.

Serials.

12868. Present Condition of the Mechanical Preparation of Ores in Saxony Hartz and Rhenish Prussia. M. Maurice Bellom (S M Q-Began April, 1893—4 parts to date—45 cts. each).

13033. Practical Hints to Boiler Makers and Templaters. Ill. (M W-Began May 12—7 parts to date—30 cts. each).

18900. The Protection of Iron and Steel from Corrosion. Ill. (I & I-Began Jan. 5—2 parts to date—30 cts. each).

19145. Cupola Management. Edward Kirk (Met W-Began Jan. 27—9 parts to date—15 cts. each).

19215. Canadian Iron Industry. George E. Drummond (C Eng-Began Jan.—3 parts to date—15 cts. each).

19676. The Manufacture of Aluminum. W. S. Sample (M W-Began Feb. 2—3 parts to date—30 cts. each).

20625. The Carbon Reactions in the Blast Furnace. William J. Hudson (I C T-Began March 9—Ended March 16—2 parts—30 cts. each).

20737. British Ore Producing Districts to Compe e with Spanish Minerals. Walter J. May (Inv-Began March 10—2 parts to date—30 cts. each).

MILITARY ENGINEERING.

*20395. An American Cruiser on Service.—The Charleston (E-March 2.) 4000 w.

*20398. H. M. S. "Hornet" (E-March 2.) 2400 w.

20502. The Successful "Indiana." Ill (Sea-March 15.) 1100 w.

*20605. Foreign Naval Activity. Editorial. (I & I-March 9.) 1100 w.

*20695. The Burial of the Guns. Thomas Nelson Page (Sc M-April.) 9800 w.

*20709. The Gunnery Trials of H. M. S. "Barfleur" (E-March 16.) 4000 w.

*20710. The Qualities and Performances of Recent First Class Battleships—with Discussion. W. H. White (E-March 16) 16000 w.

20720. How War Vessels Are Prepared for Trial. Robert W. Peck (M R C-March 22.) 2500 w.

*20739. Recent Experiments in Armor. C. E. Ellis (I C T-March 10.) 5000 w.

*20774. The Making of a Modern Fleet. W. H. White (Eng L-March 16.) 4000 w.

*20776. Boilers for Torpedo Catchers. Editorial (Eng L-March 16.) 2000 w.

20811. A Battle-Ship in Action. S. A. Staunton. (Extract from Harper's Magazine.) (Sea-March 29.) 2000 w.

20820. Some Uses of Snow Shoes. Ill. (From the London Graphic.) (Sc A S-March 31.) 1800 w.

20829. Tube Sheets and Tubes of Boilers of War Ships. Ill. (Ir Age-March 29.) 1000 w.

*20891. Turret and Turret-Moving Machinery of the United States Battleship "Texas." Ill. (A E R J-April.) 3300 w.

*20912. The Navy Estimates. Editorial (E-March 23) 3200 w.

*20933. The New Naval Programme. Editorial (Eng L-March 23.) 1800 w.

*20934. British Armor and Ordnance. Editorial (Eng L-March 23.) 1200 w.

20943. Shall We Have an American Navy? Editorial (Eng-March 31.) 1400 w.

21007. Our New Navy.—Big Guns for Big Ships (Sea-April 5.) 1300 w.

*21103. Electric Signals for War Ships. Ill. (Eng L-March 30.) 3800 w.

Serials.

20068. The Future of Naval Warfare. H. Middleton (Inv-Began Feb. 17—5 parts to date—30 cts. each).

20396. Armstrong Quick-Firing Guns. Ill. (E-Began March 2—Ended March 16—3 parts—30 cts. each).

MINING.

*20360. Gold and Silver Mining in South America. Arthur L. Pearse (E Mag-May.) 4500 w.

20388. The Asbestos Fields of Port-au-Port, Newfoundland. C. E. Willis (C Eng-March.) 1500 w.

*20403. American Quarrying Methods. Ill. Arthur Lee (I C B-March 2.) 400 w.

*20421. Mechanical Appliances for the Shipment of Coal. S. W. Allen (C G-March 2.) 7500 w.

*20423. Notes on an Occurrence of Manganese and Zinc Ore in Nova Scotia. E. Gilpin, Jr. (C G-March 2.) 1000 w.

*20424. Colliery Ventilating Machinery. (Extract.) C. M. Fercy (C G-March 2) 2400 w.

*20425. The Petroleum Industry in Galicia. M. D. Bellet (C G-March 2.) 800 w.

20509. California Mines at the Midwinter Fair (M S P-March 10) 1700 w.

20510. The Gold Mines of Plumas. J. A. Edman (M S P-March 10.) 900 w.

20539. The Sudbury Nickel Region. Ill. E. Renshaw Bush (E M J-March 17.) 3400 w.

20540. The Githens System of Rock Drilling. Ill. (E M J-March 17.) 1100 w.

20541. Canadian Lake Iron Ores. J. G. Donald (E M J-March 17.) 600 w.

*20562. Screening and Washing Floors at the Blanzy Collieries. Daniel Graillot and Dupont de Dinechin (C G-March 9.) 3000 w.

*20564. Fumat Safety Lamp (C G-March 9.) 1100 w.

*20565. The Coal Mines of West Virginia. (Abstract.) Arthur Peel (C G-March 9.) 2500 w.

20595. Coal. A. W. Wilkinson (A G L J-March 19.) 1000 w.

*20642. A Visit to the Pyrites Mines of Spain. Ill. Edward D. Peters, Jr. (A M S-Jan. 27.) 2200 w.

*20644 The Mining Industry.—Queensland.—Charters Towers.—Croydon (A M S-Feb. 3.) 3000 w.

*20646. The Bonnie Dundee Gold Mine, Queensland. Ill. (A M S-Feb. 10.) 600 w.

*20648. Auriferous Beaches on the North Coast (N. S. W.) (A M S-Feb. 17.) 2000 w.

*20649. Ceylon Gem Stones (A M S-Feb. 17.) 600 w.

20681. The Gas Engine in Mine and Mill Plants (E M J-March 24.) 1000 w.

20683. The Occurrence of Gold in the Ores of the Cripple Creek District. (Abstract.) Richard Pearce (E M J-March 24.) 900 w.

*20751. Briquette Factories at the Blanzy Collieries. Dupont de Dinechin (C G-March 16.) 1700 w.

*20753. Coking Anthracite and Non-Coking Coal Slack. Walter J. May (C G-March 16.) 1500 w.

*20754. The Parkside Hematite Mines, Cumberland. M. E. (C G-March 16.) 2000 w.

*20755. The Yorkshire Coalfield. G. E. J. McMurtrie (C G-March 16.) 1800 w.

*20762. Antiquity of Slate. George H. Harris (S-March.) 1400 w.

*20763. The Sandstones of Lake Superior. Henry G. Rothwell (S-March.) 3000 w.

*20775. Petroleum in Somersetshire. Editorial (Eng L-March 16.) 1300 w.

20806. Side Lines and End Lines.—Justice Field's Decision in the Case of Silas F. King vs. Amy and Silversmith Consolidated Mining Company (M S P-March 24.) 1800 w.

*20850. Notes on the Lower Coal Measures of Western Clearfield County, Pennsylvania. J. F. Kemp (L H P-March.) 1200 w.

20865. The New Gold Fields of the Mosquito Coast of Nicaragua. Courtenay De Kalb (E M J-March 31.) 1150 w.

20872. A Phantom of the Mines. Ill. Robert Howard Syms (Cos-April.) 4500 w.

*20888. Electric Conductors for Fiery Mines. Joseph Libert (El-March 23.) 3000 w.

*20926. A Comparison of Some Systems of Machine Screening. (Abstract.) Ill. G. E. J. McMurtrie (C G-March 22.) 2700 w.

*20927. The Working and Concentration of Dean Forest Hematites. Walter J. May (C G-March 22.) 1200 w.

21010. A Practical Talk on Mining Geology. Taylor D. MacLeod (M S P-March 31.) 1300 w.

21011. Mechanical Arrangements in Underground Operations. Extracts from paper of R. H. Wynne (M S P-March 31.) 900 w.

*21035. Cripple Creek.—Topographical and Geological Information. Ill. A. C. Lakes (C E-April.) 5000 w.

*21036. Coal Dust in Mines. Editorial (C E-April.) 1000 w.

*21037. A Complete Coke Plant.—Sewanee Mines, Tracy City, Tenn. Ill. Charles Edward Bowron (C E-April.) 2000 w.

21047. Bituminous Coals Differ in Value (B J C-April 7.) 1000 w.

21097. The Loss of Money in Investments in England (E M J-April 7.) 1300 w.

21098. Fire Doors for Mine Shafts. Ill. R. G. Brown (E M J-April 7.) 500 w.

21099. A Remarkable Folded Vein in the Ready Relief Mine. Ill. Harold W. Fairbanks (E M J-April 7.) 800 w.

*21104. The Utilization of Waste Coal. Ill. (I & I-March 30.) 2400 w.

*21106. Wheelock Winding Engine of the Blanzy Colliery. Léonard Graillot (C G-March 30.) 1800 w.

*21108. The Removal of Pyrites from Small Coal. Walter J. May (C G-March 30.) 800 w.

*21109. Explosion of Fire Damp Due to an Overcharged Shot. Ill. (C G-March 30.) 2000 w.

*21113. American vs. British Coal. (G W-March 31.) 2600 w.

*21129. Mining in Canada Region—A Rich Silver Country. (Min W-March 31.) 1300 w.

*21153. The Marble Quarries of Carrara. Ill. Arthur Lee (S-April.) 1600 w.

*21154. The Marbles of Lower Unzimkulu. Natal. J. B. & D. C. Aiken (S-April.) 1600 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E-Began Jan., 1893—15 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March, 1893—13 parts to date—30 cts. each).

11811. Information to Aid in the Search of Gold and Silver. Ill. Arthur C. Lakes (C E-Began April, 1893—Ended April, 1894—13 parts—30 cts. each).

11804. Fire Damp. H. Le Chatelier. Translated by H. Stoek (C. E-Began April 1893—Ended March, 1894—11 parts—30 cts. each).

12450. The Coal Fields of Canada. Ill. William Hamilton Merritt (C E-Began May—12 parts to date—30 cts. each).

19079. Talks on Quarrying. Ill. Edward H. Williams, Jr. (S-Began Jan.—3 parts to date—30 cts. each).

19682. The Sinking and Equipment of Shafts. Ill. (E-Began Feb. 2—3 parts to date—30 cts. each).

19919. North Queensland Goldfields (A M S-Began Jan. 6—5 parts to date—30 cts. each).

20407. Mine Surveying Methods Employed in the Coalfields of Pennsylvania. Otto C. Burkhart (C E-Began March—2 parts to date—30 cts. each).

20413. Mining Methods. Ill. (C E-Began March—2 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—2 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—2 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—2 parts to date—30 cts. each).

20223. The Cumberland Coalfield. (C G-Began Feb. 23—5 parts to date—30 cts. each).

20682. The Coal Measures of Iowa. Ill. Charles R. Keyes (E M J-Began March 24—Ended April 7—3 parts—15 cts. each).

20711. Oil Creek in the Sixties. (O P D R-Began March 26—Ended April 2—2 parts—15 cts. each).

RAILROADING.

*20359. Inclined Railway Systems of the World. Ill. Theodore C. Ives (E Mag-May.) 3000 w.

20370.—$1.50. Discussion on paper by C. D. Purdon—"Comparison of Modern Engine-Loading with Standard Specifications for Spans from 10 to 200 ft." (T C E-Dec.) 2500 w.

20371—$1.50. "Surveys for Railway Location"—Discussion of paper by F. A. Gelbcke (T C E-Dec.) 2800 w.

20372.—$1.50. Discussion on paper by E. A. Ziffer "On the Guages of Railroad Track, etc." (T C E-Dec.) 2800 w.

*20448. A Miniature Gravity Railway. Ill. (Eng L-March 2.) 4800 w.

20462. Steam Distribution for High Speed Locomotives. (Extract.) C. H. Quereau (R R-March 10.) 2700 w.

20463. English Board of Trade Regulations Regarding Signals, etc. (R R-March 10.) 1300 w.

†20476. Railway Development at Home and Abroad. J. Stephen Jeans (F R-March.) 5000 w.

20513. Some Results of the Stewart Avenue Pneumatic Interlocking. (R G-March 16.) 1300 w.

20515. Air Brakes and Their Maintenance—Abstract of Discussion on paper by G. W. Rhodes. (R G-March 16.) 2000 w.

20516. Steel Rail Specifications (R G-March 16.) 1000 w.

20517. Some of the New Railroad Work in London (R G-March 16.) 1500 w.

*20518. The Strategic Value of American Railways. T. C. Scoble (A J R A-March.) 2700 w.

20522. Recent Schemes for Electric Locomotives (E N-March 15.) 1600 w.

20547. Lubrication of Journals. F. D. Adams (R C J-March.) 2800 w.

20548. Bearing Materials and Lubrication. W. C. Dallas (R C J-March.) 1600 w.

*20593. French Commerce, Navigation and Railways (Tr-March 9.) 1500 w.

*20603. The Eisenerz-Vordernberg Abt Railway, Austria. Ill. (I & I-March 9.) 500 w.

*20606. A Run with "Petrolea." Charles Rous-Marten (Eng L-March 9) 4600 w.

*20614. The Forthcoming Railway Congress. Editorial (E-March 9.) 1800 w.

20622. "Lying, Cheating and Stealing."—Remarkable Charge by the Louisville and Nashville against Competing Lines, with Editorial. M. H. Smith (R A-March 16) 7000 w.

20631. The Ball Balanced Compound Locomotive. Ill. (R R-March 17.) 1000 w.

20664. A Difficult Piece of Construction in London. C. H. G. (R G-March 23.) 900 w.

20665. Old English Locomotives. Ill. (R G-March 23.) 650 w.

20666. A Railroad Connecting the Shores of the Arctic with St. Petersburg (R G-March 23.) 850 w.

20667. A Movement to Use Green for an "All Clear" Night Signal. Editorial (R G-March 23.) 1800 w.

20668. Cheap Railroad Working in India (R G-March 23.) 3000 w.

20669. Counterbalancing in the Laboratory and on the Track (R G-March 23) 1200 w.

*20713. Has the Inter-State Commerce Law Been Beneficial? Aldace F. Walker (F-April.) 4800 w.

*20719. Electric Roads in Country Districts. (Reprint from N. Y. Evening Post.) (S R E N-March.) 1500 w.

20724. State Supervision of Railway Crossings (R A-March 23.) 900 w.

*20733. Locomotive Builders Drafting Room System. J. S. Reid (S J E-March.) 2500 w.

*20738. Russian Railways and Waterways (Tr-March 16.) 900 w.

20778. Need for and Plan of Disseminating Knowledge Concerning Railways. George de Haven (R R-March 24.) 4200 w.

20781. Dynamometer Car on the Paris, Lyons and Mediterranean Railway, with Editorial. Ill. (R R-March 24) 2500 w.

20834. Railway Development and Commerce in the Republic of Colombia (E N-March 29.) 1600 w.

20842. Comparative Tests of English and American Railroad Trains. Ill. (R G-March 30.) 3500 w.

20843. The Ninety-Third Street Subway under the Illinois Central Railroad Tracks. Ill. (R G-March 30.) 1200 w.

20844. Mr. Depew on the Trunk-Line Situation (R G-March 30.) 1400 w.

20845. Grade Crossing Laws (R G-March 30.) 900 w.

20846. Track Elevation in Chicago (R G-March 30.) 2000 w.

20851. Differential Block System. Ill. (W E-March 31.) 1000 w.

*20852. A Railroad Profile of Some Use. C., St. P. and K. C. R'y. Ill. (L E-April.) 300 w.

20863. $1.50. Railroad Location, with Discussion. Michael L. Lynch (T C E-Jan.) 18800 w.

*20886. The Board of Trade Electric Traction Regulations, with Editorial (El-March 25.) 3000 w.

*20913. The Great Venezuelan Railway (E-March 23.) 1400 w.

*20921. Railway Accident Insurance in Prussia (Tr-March 23.) 600 w.

*20922. French Train Speeds (Tr-March 23.) 700 w.

*20939. A System of Tracing Train Delays. (N C B-April.) 550 w.

20957. Queen and Crescent Answers Louisville and Nashville. S. M. Felton (R A-March 30.) 1800 w.

20958. Quirk's Train Tablet Exchange. Ill. (R A-March 30.) 1100 w.

20961. The Herculaneum Bridge Disaster and Public Prejudice Against Railways. Quinton McNab (R R-March 31.) 900 w.

20963. Advanced or Back Charges. Editorial (R R-March 31.) 1100 w.

21013. The Construction of a Short Tunnel; W. Va. and P. R. R. (Abstract.) Ill. J. G. G. Kerry (E N-April 5) 3200 w.

21019. Some Track Buffers. Ill. James F. Hobart (R G-April 6.) 1300 w.

21020. What Is an Economical Load for a Locomotive? (Abstract.) George W. West (R G-April 6.) 1000 w.

21022. The International Railroad Congress. Editorial (R G-April 6.) 1200 w.

21071. Terminal Yards. J. B. Morford (R A-April 6.) 1000 w.

*21088. London, Chatham, and Dover Express Engines. Ill. Clement E. Stretton (R W-March.) 900 w.

*21090. Pullman Cars. Ill. (R W-March.) 1800 w.

*21091. The Vacuum Automatic Brake.—Messrs. Gresham and Craven's Works. Ill. (R W-March.) 3600 w.

*21127. Market Traffic Rates in Europe and America (Tr-March 30.) 1500 w.

*21134. Railway Extension in India, and Its Relation to the Trade of India and of the United Kingdom, with Discussion. Joseph Walton (J S A-March 30.) 8800 w.

21146. The Locomotive "General." Ill. (R R-April 7.) 900 w.

21148. Documents to Be Sent to the Railway Department, Board of Trade, Previously to the Second Notice of the Intention to Open a Railway Being Given (R R-April 7.) 3500 w.

Serials.

12001. Rails on the Creep. A. Ewbank (I E-Began March 11, 1893—43 parts to date—45 cts. each).

15496. Railroad Coppersmithing. Ill. John Fuller, Sr. (L E-Began Sept.—8 parts to date—30 cts. each).

17464. Vancouver to Chicago. Killingworth Hedges (I & I-Began Nov. 10—4 parts to date—30 cts. each).

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M-Began Dec.—5 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan.—3 parts to date—15 cts. each).

18957. Ventilation of Passenger Cars. James F. Hobart (R C J-Began Jan.—4 parts to date—15 cts. each).

20112. Vestibules, Platform Canopies and Hoods. Ill. (R G-Began March 2—Ended March 23—3 parts—15 cts. each).

20611. The Mont Selève (Geneva) Electric Rack Railway. Ill. C. S. Du Riche Preller (E-Began March 9—2 parts to date—30 cts. each).

20632. Railway Management. Horace Cope (R R-Began Dec. 1, 1892—11 parts to date—15 cts. each).

20780. Rail Depression and Strain under Locomotives. Ill. (R R-Began March 24—2 parts to date—15 cts. each).

20892. Signal Apparatus in Use on the Grand Central Railway of Belgium. Leopold Kirsch (A E R J-Began April—1 part to date—30 cts).

20959. Ought the Government to Own the Railways? George H. Lewis (R R-Began March 31—2 parts to date—15 cts. each).

20962. Track Maintenance. Edward Laas (R R-Began March 31—2 parts to date—15 cts. each).

STREET RAILWAYS.

*20362. The Storage Battery and Its Uses. Townsend Wolcott (E Mag-May.) 3000 w.

20373.—$1.50. "Transmission of Power in Operating Cable Railways"—Discussion of paper by Robert Gillham (T C E-Dec.) 3200 w.

*20456. The Liverpool Overhead Railway (I C T-March 2.) 1800 w.

20474. Capacity of Railway Motors. E. A. Merrill (E E N Y-March 14.) 650 w.

*20508. Rapid Transit Possibilities—The Moving Platform System. Ill. (E M-March.) 900 w.

20514. The "Hillside" Loops of the North Hudson County Railway. Ill. (R G-March 16.) 600 w.

†20557. Discussion of Paper by H. Ward Leonard on "How Shall We Operate an Electric Railway 100 Miles From the Power Station," with description of apparatus (T A I E E-March.) 10500 w.

20566. Advisability of Insurance of Street Railway Companies Against Liability for Wrong Doing. R. D. Fisher (S R G-March 17.) 800 w.

*20602. The Liverpool Overhead Railway—Abstracts of papers by Messrs. Greathead and Fox, and T. Parker, with discussion (I & I-March 9.) 5800 w.

*20619. Storage Battery Traction for Street Tramcars. Editorial (P Eng-March 9.) 1200 w.

20656. The Waddell-Entz Storage Battery Car Traction Plant of the Second Avenue Railroad Company, New York (Sc A-March 24.) 1700 w.

*20694. Storage Battery Cars. George J. Varney (L Mag-April.) 1800 w.

20786. Rapid Transit. (Extract.) Albert L. Clough (S R G-March 24.) 2000 w.

20787. The Aerodromic System of Transportation. Ill. (E R N Y-March 28.) 1300 w.

20789. The Barrows System of Transportation. Ill. (E R N Y-March 28.) 1300 w.

20841. Rapid Transit in Baltimore. J. C. Ransom (R G-March 30.) 1400 w.

20954. Paris Underground Electric Railway. Ill. (S R G-March 31.) 700 w.

20972. The Silvey Storage Car System. Ill. (E E N Y-April 4.) 2400 w.

20978. Steam Tramcars With Serpollet's Boiler. Ill. (Sc A-April 7.) 1300 w.

†20989. A Modern Car House—Citizens Traction Co., Pittsburg, Pa. Ill. (S R J-April.) 1350 w.

†20991. Narrow vs. Broad Gauge Electric Railways. E. A. Merrill (S R J-April.) 1500 w.

†20992. Proper Rail Bonding. (Abstract.) H. J. Malochee (S R J-April.) 2300 w.

†20993. Street Railways in Montgomery, Mobile and New Orleans. Ill. (S R J-April.) 10500 w.

21072. Electric Power Plant for the New Haven Street Railway Company. Ill. (E I-April.) 1000 w.

*21089. The Dresden Electric Tramway. Ill. (R W-March.) 1600 w.

Serials.

18549. The Intrinsic Value of Street Railway Investments. Edward E. Higgins (S R J-Began Jan. 1—4 parts to date—45 cts. each).

18711. Electric Railway Motors: Their Construction and Operation. Ill. Nelson W. Perry (S R G-Began Jan. 6—13 parts to date—15 cts. each).

19306. The Third Avenue Cable Railway of New York City. Ill. (E N-Began Feb. 1—4 parts to date—15 cts. each).

20206. The Electric Tramway at Remscheid. Ill. Julius Maier (E L-Began Feb. 23—2 parts to date—30 cts. each).

21092. The Relative Economy of Cable and Electric Tramways (R W-Began March—1 part to date—30 cts).

SANITARY ENGINEERING.

*20366. An Unsettled Question in Ventilation. Leicester Allen (E Mag-May.) 2000 w.

20383.—$1.50. Purification of Sewage and of Water by Filtration.—Discussion on paper by Hiram F. Mills (T C E-Dec.) 2500 w.

*20386. Sewer Gas and Zymotic Disease. A. C. Ranyard (K-March 1.) 3800 w.

*20397. Public Health. Editorial (E-March 2.) 2700 w.

20534. The Sanitation of Santos, Brazil. Ill. (E R-March 17.) 2600 w.

*20559. Sanitary Inspectors. — Tenure of Their Appointments (S R-March 10.) 1500 w.

*20575. The Hermite Sanitary Process (E R L-March 9.) 1300 w.

20623. Heating and Ventilation (R & T-March.) 2800 w.

*20707. The Submerged Sewer at Shirley Gut, Boston, Mass. (E-March 16.) 2000 w.

†20810. Experiments with Glazed Stoneware Pipes (I E-Feb. 24.) 600 w.

20835. Drinking Water at the World's Columbian Exposition. Allen Hazen (E N-March 29.) 1500 w.

†21024. Out of Sight, Out of Mind.—Methods of Sewage Disposal. George E. Waring, Jr. (C M-April.) 10000 w.

Serials.

5358. Sewage Purification in America. Ill. (E N-Began July 14, 1892—40 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1, 1893—Ended March 24, 1894—28 parts—30 cts. each).

18870. Humidity and Ventilation. Joseph Masinette (A Ar-Began Jan. 13—3 parts to date—15 cts. each).

19813. American Plumbing (D E-Began Feb.—2 parts to date—30 cts. each).

20014. Plumbing in the Metropolitan Building. Ill. (E R-Began Feb. 24—2 parts to date—15 cts. each).

20194. Sewage Disposal. George E. Waring, Jr. (E R-Began March 3—2 parts to date—15 cts. each).

21132. Sanitary Law. A. Wynter Blyth (I C B-Began March 30—1 part to date—30 cts).

STEAM ENGINEERING.

*20447. Circulation in Water-Tube Boilers. Editorial (Eng L-March 2.) 2000 w.

20481. Some Ancient Reaction Engines. Ill. W. F. Durfee (Sc A-March 17.) 1700 w.

20490. Lubricators and Lubrication. W. H. Wakeman (A M-March 15.) 700 w.

20491. An Instance of Steam Economy. Edward J. Willis (A M-March 15.) 700 w.

*20507. Losses of Heat in Combustion of Fuels (E M-March.) 3000 w.

20543. Origin and Development of Steam Navigation (Eng-March 17.) 2500 w.

20544. Returns in Heating Systems.—How Check Valves Should be Arranged. Ill. (B J C-March 17.) 500 w.

20545. Anti-Friction Materials.—Their Use as Dry Bearings for Machinery (B J C-March 17.) 1700 w.

*20607. On the Systematic Production of Steam from Sixty-eight Boilers at the "Say" Sugar Refinery, Paris. Ill. Bryan Donkin (Eng L-March 9.) 4500 w.

20654. How to Operate a Steam Boiler. Jarvis B. Edson (E E N Y-March 21.) 3500 w.

20684. About Chimneys.—The Importance of Height (B J C-March 24.) 1000 w.

20731. Steam Boilers and Treatment and Purification of Water (M G-March 24.) 4000 w.

*20740. Leaves from a Laboratory Note Book. Some Points Affecting the Transmission of Heat in Steam Boilers. Vivian B. Lewis (I C T-March 10.) 3000 w.

*20777. Some Experiments with Triple-Expansion Engines at Reduced Powers. D. Croll (Eng L-March 16.) 1900 w.

20804. Locomotives as Stationary Engines. Editorial (A M-March 29.) 1100 w.

20805. The Development of the Steam Engine Indicator. (Extract.) Harris Tabor (A M-March 29.) 3300 w.

20819. New Steam Carriage. Ill. (Sc A-March 31.) 1500 w

20822. Cracked Plates. Ill. (S E-Jan.) 1300 w.

20837. Sulzer Triple-Expansion Vertical Engine of 1300 H. P. Ill. (E N-March 29.) 600 w.

*20854. Cylinder Compensation. Editorial (L E-April.) 1300 w.

20942. Repeating Apparatus for Indicators. Ill. George Sieurin (P S-April.) 600 w.

20970. Progress in Exhaust Steam Heating. J. H. Babcock (E E N Y-April 4.) 800 w.

20974. The Indicated Horse Power of a Compound Condensing Engine. W. H. Wakeman (S M-April 1.) 400 w.

*21005. The Evolution of Steam Engines. John E. Sweet (I S F-April.) 4800 w.

*21032. The Lancashire Boiler. Ill. W. H. Booth (C E-April.) 800 w.

21046. Steam Engine Design.—Advantages of the Different Types (B J C-April 7.) 1600 w.

21050. The Limitation of Engine Speed (M G-April 7.) 2000 w.

*21061. The Livet System of Generating Steam by the Destruction and Combustion of Town Refuse. Ill. (M-Feb. 15.) 1800 w.

*21063. Coal and "Coal." Editorial (El-March 30.) 1000 w.

*21076. Fractures in Caustic Soda Boilers. Editorial (P Eng-March 30.) 1200 w.

*21086. Morton's Steam Turbine. Ill. (E R L-March 30.) 1600 w.

*21101. Mr. Croll on Condensation in Cylinders. Editorial (Eng L-March 30.) 1600 w.

Serials.

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M-Began March, 1893.—Ended April, 1894—14 parts—30 cts. each).

17823. Designing Corliss Gears. Ill. James Dunlop (P Eng—Began Nov. 24—6 parts to date—30 cts. each).

18986. Boiler Calculations. James F. Hobart (S M-Began Jan. 15—4 parts to date—15 cts. each).

19709. The Indicator and Its Diagrams. Ill. Charles Day (P Eng-Began Feb. 2—6 parts to date—30 cts. each).

20182. The Elements of Boiler Making. C. E. Fourness (I. E-Began March—2 parts to date—30 cts. each).

20568. The Stationary Engineers as They Were and as They Are. Stephen Roper (S V-Began March 15—1 part to date—15 cts).

20680. The Steam Jacket. Thomas Main (Am S-Began March 22—3 parts to date—15 cts. each).

21064. The Testing of Engines and Boilers. Alex. B. W. Kennedy (El-Began March 30—1 part to date—30 cts).

21141. High Speed Steam Engines. John Radinger (E M-Began April—1 part to date—30 cts).

TELEPHONY AND TELEGRAPHY.

*20616. The Telegraph Engineers in India. Editorial (E-March 9.) 900 w.

20628. $50,000,000 for Telephoning.—The American Bell Telephone Company's Argument for Increase of Capital. (E R N Y-March 21.) 5500 w.

†20637. A Century of the Telegraph in France. Ill. Walter Lodian (P S M-April.) 2500 w.

20703. A Phase of Telephone Engineering. Angus S. Hibbard (E E-March.) 2200 w.

*20736. A History of the Telephone and the Expiry of Original Patents. (Inv-March 10.) 2800 w.

20985. Steering by Telephone in a Fog. (Reprint from Pall Mall Gazette.) (E R N Y-April 4.) 600 w.

20987. The Carbon Telephone Patents. Editorial (E R N Y-April 4) 1800 w.

20994. A Telephone Cable Test. C. W. Swoope (E N Y-April 4.) 300 w.

21049. The Repeating Coil as Used in Telephony. Ill. W. H. Hyde (W E-April 7.) 1200 w.

*21081. Graham's Electric Loud Talking Apparatus. Ill. (Inv-March 31.) 600 w.

*21083. Electric Communication between Lightships and the Shore. Editorial (Inv-March 31.) 600 w.

Serials.

18628. The Electro-Magnet; or Joseph Henry's Place in the History of the Electro-Magnetic Telegraph. Ill. Mary A. Henry (E E N Y-Began Jan 3—8 parts to date—15 cts. each).

20069. Visual Telegraphy.—A Review of the Work in this Field. Ill. N. S. Amstutz (E N Y-Began Feb. 28—3 parts to date—15 cts. each).

MISCELLANEOUS.

*20357. Wider Markets for American Manufactures—The Industrial Problem of the Day. Hawthorne Hill (E Mag-May.) 3000 w.

*20361. The Northern White Pine Industry. Ill. Richard A. Parker (E Mag-May.) 3000 w.

20377.—$1.50. "Topographic Surveys." Ill. Discussion on paper by Herbert G. Ogden (T C E-Dec.) 9000 w.

20378 —$1.50. The Use of Long Steel Tapes. Discussion on paper by R. S. Woodward (T C E-Dec.) 3500 w.

*20393. Technical vs. Literary Education. Editorial (I & I-March 2.) 1000 w.

*20405. The Observation and Creation of Beauty. William Morris (A L-March 2.) 3200 w.

*20406. The Arts and Industries of Belgium, and the Antwerp Exposition, 1894—with Discussion. Edward Sève (J S A-March 2.) 11800 w.

*20454. Flying Machines. Gavin J. Burns (S L-March.) 2000 w.

*20457. Engineers of To-Day and Yesterday. John Fritz—W. H. Jaques. Ill. (E Rev-Feb. 20.) 2900 w.

†20468. A Relation of Engineering to Progress and Civilization. F. R. Hutton (S M Q-Jan.) 2000 w.

†20471. Scientific Problems of the Future. H. Elsdale (C R-March.) 6300 w.

†20477. From Cape Town to Cairo. Henry W. Lucy (F R-March.) 4900 w.

†20492. The Caoutchouc Supply from British India. Clements R. Markham (I R W-March 15.) 4800 w.

†20493. I. The Proper Place for Rubber Cultivation. Courtenay DeKalb. II. Articles on Rubber Culture (I R W-March 15.) 2500 w.

*20523. Toronto Technical School (Can A-March.) 3000 w.

*20524. Rocks. A. P. Coleman (Can A-March.) 2000 w.

†20531. Mortgage Banking in America. D. M. Frederiksen (J P E-March.) 8700 w.

†20538. The Land Laws of New Zealand. Edward Reeves (W R-March.) 4000 w.

*20608. Paris a Seaport. Editorial (Eng L-March 9.) 1500 w.

20634. The Position and Prospects of Aerial Navigation (Min R-March 15.) 1500 w.

†20636. New Lights on the Problem of Flying. Ill. Joseph Le Conte (P S M-April.) 5500 w.

†20638. On New England and the Upper Mississippi Basin in the Glacial Period. James D. Dana (P S M-April.) 1400 w.

†20639. The Origin of Art. W. Lazar Popoff (P S M-April.) 2800 w.

*20651. The Evolution of a Statue. F. Weitenkampf (Ch-April.) 3400 w.

20699.—$1. A History of Political Economy. Gustav Cohn (An A A-March.) 45000 w.

20705.—$1. The Idea of Justice in Political Economy. Gustav Schmoller (An A A-March.) 13300 w.

*20712. What "Americanism" Means. Theodore Roosevelt (F-April.) 5500 w.

*20732. An Address to Young Engineers. George W. Melville (S J E-March.) 3000 w.

*20756. The Newest Flying Machine. The "Maxim" Air-Ship Inspected and Described. (M-March 15.) 2300 w.

20782. A Trade or a Profession? C. R. Tompkins (A S-March 24.) 1000 w.

†20795. Tariff Reform and Monetary Reform. E. B. Andrews (N A R-April.) 5600 w.

†20796. An Anglo-American Alliance. Arthur Silva White (N A R-April.) 4000 w.

†20797. How We Restrict Immigration. Joseph H. Senner (N A R-April.) 2400 w.

20838. Abolishing the Coast and Geodetic Survey (E N-March 29.) 1400 w.

*20868. The Indian Currency, with Discussion. J. Barr Robertson (J S A-March 23.) 33000 w.

20877. Flying Devices. Ill. George Crosland Taylor (Aer-April.) 5000 w.

20878. The Flying Man. Ill. Otto Lilienthal (Aer-April.) 5200 w.

*20890. The Problem of Man Flight. Editorial (Inv-March 24.) 2000 w.

*20894. Men of Metal. Hiram S. Maxim (I & I-March 23.) 3000 w.

*20916. A Technical Utopia, Limited.—Currie Residential Technical Schools, Folkestone. Ill. (E R L-March 23.) 5000 w.

*20917. Engineers of To day and Yesterday.—James Brindley—Edward Leader Williams. Ill. (E Rev-March 20.) 3300 w.

*20923. Josiah Wedgwood (A L-March 23.) 2000 w.

*20950. Popular Mistakes About Taxation (S Ec-April) 2400 w.

*20951. Economic Theory Concerning Value. Van Buren Denslow (S Ec-April.) 3800 w.

20976. Mechanical Engineering Building of the Case School of Applied Science. Ill. (S M-April 1.) 1000 w.

20979. Carborundum. Ill. (Sc A-April 7.) 1300 w.

21014. Wire Glass (E N-April 5.) 1500 w.

21023. A Raid on the Coast Survey (R G-April 6) 1500 w.

*21026. Negro Progress on the Tuskegee Plan. Ill. Albert Shaw (R of R-April.) 4500 w.

*21055. Theory and Practice. Gavin J. Burns (S L-April) 1700 w.

†21066. On a New Horizon and Some New Localities for Friable Sandstone in Which the Grains are Enlarged by Secondary Deposition of Silica in Optical Continuity with the Original Nucleus. Ill. Samuel Calvin (A G-April.) 1000 w.

†21068. A Classification of Economic Geological Deposits Based on Origin and Original Structure. W. O. Crosby (A G-April.) 6000 w.

†21069. Geology of Jefferson County, Texas. W. Kennedy (A G-April) 2000 w.

†21070. British Drift Theories. Warren Upham (A G-April.) 1000 w.

*21124. Irish Geology (A L-March 30.) 1200 w.

*21125. The Excavation of Deir el Bahari (A L-March 30.) 1400 w.

*21126. Nature and Art. (Extract.) F. Suddards (A L-March 30.) 1500 w.

*21135. The Har Dalam Cavern and Its Ossiferous Contents (N-March 29.) 1200 w.

†21166. Pages in the History of Allotments. J. Frome Wilkinson (C R-April.) 5700 w.

21189. The Maxim Air Ship. Ill. H. J. W. Dam (Sc A-April 14.) 4800 w.

21219. Sectional Lenses. (Reprint from the Chicago Tribune.) (Eng.-April 14.) 800 w.

21227. Scientific Work at Cornell (R G-April 13.) 1400 w.

*21277. The Elements of Beauty in Ceramics. Charles F. Binns, with Discussion (J S A-April 6.) 7400 w.

*21295. Engineering Works on the Thames. Messrs. John and Henry Gwynne. Ill. (Eng. L-April 6.) 4500 w.

*21305. Wedgwood as a Potter (A L-April 6.) 2000 w.

*21320. The Production of Artificial Marble According to the Moreau-Rae Process (Inv-April 7.) 1500 w.

†21322. What may happen to a British Captain—The "Costa Rica Packet" Case. J. F. Hogan (W R-April.) 5200 w.

†21323. The Principles of Betterment. Hugh H. L. Bellot (W R-April.) 5800 w.

†21325. Our Colonies and Free Trade. A Plea for a Customs Union of the British Empire. W. Peart-Robinson (W R-April.) 4500 w.

Serials.

14653. Theory vs. Practice. W. M. Patton (S-Began July—9 parts to date 30 cts. each).

16290. The Atmosphere as a Medium of Travel. Fred W. Brearey (I & I-Began Sept. 15—10 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

16514. The Evolution of Artificial Light. Ill. E. L. Lomax (P A-Began Oct. 16—Ended March 15—9 parts—15 cts. each).

17553. Management of Men and Manufacturing Industries. Thomas D. West (Ir Age-Began Nov. 23—7 parts to date—15 cts. each).

18930. Carnot and Modern Heat. Dr. Oliver Lodge (Eng L-Began Jan. 5—9 parts to date—30 cts. each).

19052. Notes on the Manufacture of Ropes. Ill. W. C. Popplewell (P Eng-Began Jan. 12—4 parts to date—30 cts. each).

19453. Contributions to the Chemistry of India-Rubber. P. Carter Bell (I R W Began Jan. 15—2 parts to date—45 cts. each).

20802. Measurement of High Temperatures. A. Humboldt Sexton (P Eng-Began March 23—1 part to date—30 cts).

21067. Geological Notes on the Sierra Nevada. H. W. Turner (A G-Began April—1 part to date—45 cts).

THE·TECHNICAL·INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS index has been very properly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings, that within a few minutes, once a month, an active man can learn of everything of any importance that has been published during the month in relation to the subjects in which he is interested. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential improvement—namely: that in addition to indicating *just when and where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

IN ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents; those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents; and where the cost is above this, the price is given immediately after the number. In every case the price is closely regulated by the cost to us of a single copy of the publication from which the article is taken.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. W=words.]

THE AMERICAN PRESS.

A .....Arena. *m.*. $5. Boston.
AA.....American Architect. *w.* $6. Boston.
Aer.....Aeronautics. *m.* $1. N. Y.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
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21777. Cost of Electrical Energy. R. E. Crompton (El-Began April 27—1 part to date—30 cts.).

ELECTRIC POWER.

*21156. The Electric Transmission of Power. F. B. Crocker (E Mag-June.) 3000 w.

21180. The Canal Contract.—Full Text of the Agreement (E N Y-April 11.) 2000 w.

21221. Electric Power in Mills and Factories (M G-April 14.) 1500 w.

21272. Electricity on the Canals (P A-April 16. 1300 w.

*21294. Electric Transmission of Power from the Periyar River, Southern India (Eng L-April 6.) 2800 w.

21336. Sprague-Pratt Electric Elevators.—The Postal Telegraph Plant in the New Broadway Building. Ill. (E R N Y-April 18.) 4800 w.

21356. Storage Battery Lighting and Car Propulsion (Sc A-April 21.) 1250 w.

21370. Electric Transmission of Power in Chicago.—Factories of the Western Electric Company. Ill. (W E-April 21.) 1400 w.

*21423. Portable Electricity. John Trowbridge (Ch-May.) 3000 w.

*21457. The Electric Power Plant at Dumbreck Colliery, Kilsyth. James T. Forgie (I C T-April 13.) 3600 w.

*21459. Electric Power Station at the Decize Colliery, Saone-et-Loire, France. M. C. Walckenaer (C G-April 13.) 1700 w.

*21495. Power Transmission by Means of High Pressure Direct Currents. E. Schulz (El-April 13.) 800 w.

*21646. Electric Power Installations in Engineering and Iron Works. D. Selby-Bigge. (C G-April 20.) 1400 w.

21661. An Estimate of the Distance to Which Niagara Water Power Can Be Economically Transmitted by Electricity. Edwin J. Houston and A. E. Kennelly, with Editorial. (E E N Y-May 2.) 3000 w.

21686. Textile Manufacturing by Electric Power—Taftville, Conn. Ill. (E R N Y-May 2.) 1400 w.

21687. Chicago's Electric Department. Fred De Land. (E R N Y-May 2.) 800 w.

†21761. The Electric Motor. F. B. Crocker. (J F I-May.) 3200 w.

*21771. Editorial on Professor Kennedy's Address to the Mechanical Engineers. (E R L-April 27.) 1800 w.

*21772. I. Regulation and Governing of Electromotors. Editorial. II. A New System of Regulating Motors—H. Ward Leonard's. Ill. (E R L-April 27.) 3500 w.

*21812. Electrical Transmission of Power at the Masse-Diarbois Colliery, Ransart. Ill. Emile Gosseries. (C G-April 27.) 2000 w.

Serials

9858. The Calculation of Alternating Current Motors. Ill. E. Arnold (E W-Began Jan. 21, 1893—9 parts to date—15 cts. each).

11560. Electric Motor Power. Ill. Albion T. Snell (El-Began March 17, 1893—16 parts to date—30 cts. each).

21698. The Practical Importance of Resonance in the Transmission of Electrical Power. F. W. Dunbar (E W-Began May 5—2 parts to date—15 cts. each).

21776. Professor A. B. W. Kennedy's Presidential Address to the Institution of Mechanical Engineers (El-Began April 27—1 part to date—30 cts).

GAS ENGINEERING.

*21211. The Construction of Gasholders. (Abstract.) E. Lloyd Pease (J G L-April 3.) 3800 w.

21270. Gas Companies and the Public. W. C. Boyle, with Discussion (A G L J-April 16.) 6000 w.

21271. The Joint Business of Gas and Electric Light. Howard Jones, with Discussion (A G L J-April 16.) 10500 w.

21273. Gas for Fuel. Donald M'Donald, with Discussion (P A-April 16.) 6500 w.

*21275. A Great Gas Corporation from an Investment Point of View (L H P-April.) 1800 w.

*21276. Improvement in Scrubbing, Purifying and Condensing Gas. Ill. (L H P-April.) 1000 w.

*21284 Photometry. (Abstract.) W. de W. Abney (E-April 6.) 2000 w.

*21400. The Construction of Gas Works. (Abstract.) Charles Hunt (J G L-April 10.) 2000 w.

*21401. The Construction of Gasholders.—Discussion of Paper by E. Lloyd Pease (J G L-April 10.) 6500 w.

*21430. London Coal-Gas and Its Enrichment. Vivian B. Lewes, with Discussion. (J S A-April 13.) 9200 w.

*21440. Photometry. (Abstract of 2d Lecture.) W. de W. Abney (E-April 13.) 1500 w.

*21458. The Pressure and Expansion of Gases and Steam. (A J R A-April.) 800 w.

*21546. A Visit to the Lancaster Gasworks (G E M-April 10.) 2800 w.

*21547. Protecting Gas Pipes. (G E M-April 10.) 1800 w.

*21636. Inaugural Address of Norton H. Humphrys (G W-April 21.) 6800 w.

*21637. Inaugural Address of W. J. Carpenter (G W-April 21.) 3700 w.

*21644. Photometry. (Abstract of 3d and Last Lecture.) W. de W. Abney (E-April 20.) 2000 w.

21654. Water Fuel Gas.—The Peters Patent. Ill. (A M & I W-April 27.) 1600 w.

*21758. The Prepayment Meter System. G. J. Gough (J G L-April 24.) 1200 w.

*21795. The Sacrifice of Heat in Making

Producer Gas. James Ormiston (I C T-April 27.) 3000 w.

*21796. Notes on the Efficiency of Gaseous Fuel. F. A. Matthewman (I C T-April 27.) 2000 w.

*21809. Public Waste in Gas Consumption. Vivian B. Lewes (B A-April 27.) 900 w.

*21829. Retorts and Chimneys. A. Thomas, with Discussion (G W-April 28.) 3300 w.

Serials.

19815. Gas for the Household. William Paul Gerhard (D E-Began Feb.—3 parts to date—30 cts. each).

20417. Gas Stoves and Ventilation. Edward J. Smith (Pl D-Began March—2 parts to date—30 cts. each.

21052. The Development of the Gasholder. A. M'I. Cleland (J G L-Began March 27—2 parts to date—30 cts. each).

21760. On Gas Burners, Gas Pressure Regulators and Governor Burners, Gas Globes and Globe Holders, and Gas Fixtures. William Paul Gerhard (J F I-Began May—1 part to date—45 cts.

21887. Testing Gas Engines. Ill. (M W-Began May 4—1 part to date—30 cts).

HYDRAULICS.

*21347. The Cumberland (Q.) Dam Disaster (A M S-March 10.) 1300 w.

21378. Proposed Supplementary Water Supply for Duluth, Minn. W. H. Hoyt (E N-April 19) 700 w.

21380. Sewall Falls Dam Across the Merrimac River near Concord, N. H. Ill. Daniel Ulrich (E N-April 19.) 1400 w.

21397. Burlington's (Ia.) New Filter System (F W-April 21.) 900 w.

21418.—$1.50. The Water Works of Denver, Col., with Discussion. Ill. James D. Schuyler (T C E-Feb.) 16000 w.

21506. The Electrolysis of Water Pipes (E R-April 21.) 3000 w.

*21522. Irrigation from the Yellowstone River. Charles Tappan (J A E S-Feb.) 2000 w.

*21523. Water Power—Its Measurement and Value. George A. Kimball, with Discussion (J A E S-Feb.) 6500 w.

21567. The Niagara Falls Paper Company's Power Plant. Ashley B. Tower (E N-April 26.) 1600 w.

*21643. The Assouan Dams on the Nile. Ill. (E-April 20.) 1500 w.

*21648. The Application of Hydraulic Machinery to the Manchester Trade. (Abstract.) Gilbert Lewis (C G-April 20.) 1200 w.

21656. The Venturi Meter (M G-April 28.) 1300 w.

*21681. Hydraulic Boat Lifts. Ill. G. Braet (A E R J-May.) 1800 w.

*21793. San Roque Dam, Argentine Republic. Ill. (Eng L-April 27.) 1800 w.

21826. Pumps and Pumping. William Perry (C Eng-May.) 2800 w.

21898.—$1.50. Driven Wells of the Plainfield Water Supply System. L. L. Tribus, with Discussion (T C E-March.) 8000 w.

Serials.

18676. The Pumping Engine: Its Many Points, Faults and Peculiarities. Ernest W. Naylor (F W-Began Jan. 6—12 parts to date—15 cts. each).

18801. Discharge of Sluices and Weirs Under Varying Heads. G. C. Maconchy (I E-Began Dec. 9—10 parts to date—45 cts. each).

20808. Ahmedabad Water Works Report. Ill. (I E-Began Feb. 24—4 parts to date—45 cts. each).

21015. Stand Pipe Accidents and Failures. Ill. William D. Pence (E N-Began April 5—5 parts to date—15 cts. each).

21021. The Missouri River. (Extracts.) O. B. Gunn (R G-Began April 6—2 parts to date—15 cts. each).

21311. Water Power at Worcester (I C B-Began April 6—2 parts to date—30 cts. each).

21405. The Coefficients of Discharge of the Kistna Anicut. Ill. Alfred Chatterton (I E-Began March 17—3 parts to date—45 cts. each).

21433. Glasgow Water Works. Ill. (E-Began April 13—2 parts to date—30 cts. each).

21551. Application of Hydraulic Machinery to the Manchester Trade. Gilbert Lewis (M W-Began April 20—2 parts to date—30 cts. each).

INDUSTRIAL CHEMISTRY.

*21291. The Chemical Industry of the United States (I & I-April 6) 1600 w.

*21301. Ira Remsen on Chemical Laboratories—Address delivered at the opening of the Kent Chemical Laboratory, Chicago (N-April 5) 5800 w.

†21364. An Attempt to Find the Amount of Phosphorus in Three Samples of Steel. Charles B. Dudley and F. N. Pease (J A C S-April.) 2200 w.

†21365. On Some Points in the Determination of Phosphorus in Steel by the Volumetric Method. Charles B. Dudley and F. N. Pease (J A C S-April.) 1800 w.

†21366. The Exact Determination of Phosphorus by the Molybdate Method in Iron, Steel, and Ores which Contain Arsenic. James O. Handy (J A C S-April.) 600 w.

†21367. Notes and Queries on Mr. Dudley's Method of Determining Phosphorus in Steel. O. S. Doolittle and Alban Eavenson (J A C S-April.) 4000 w.

†21368. On the Qualitative Determination of Tanning Materials. H. R. Procter (J A C S-April.) 1700 w.

†21429. Ancient and Mediæval Chemistry. M. P E. Berthelot (P S M-May.) 5000 w.

*21788. A Model Laboratory (I C B-April 27.) 1200 w.

Serials.

17576. Theoretical and Practical Ammonia Refrigeration. Iltyd I. Redwood (Eng-Began

Nov. 25—Ended April 14—11 parts—15 cts. each).

19453. Contributions to the Chemistry of India-Rubber. P. Carter Bell (I R W-Began Jan. 15—3 parts to date—45 cts. each).

INDUSTRIAL SOCIOLOGY.

*21159. The Coxey Crusade and Its Meaning. William Nelson Black (E Mag-June.) 3000 w.

21196. Tariff Criticism in Canada (Ir Age-April 12.) 1200 w.

21197. Compulsory Labor Insurance (Ir Age-April 12.) 2200 w.

*21210. Mather on the Forty-Eight-Hour Week (J G L-April 3.) 2200 w.

21224. Labor and the Strike. A. B. Salom (I I G-April.) 1400 w.

21235. The Injustice of Strikes (B J C-April 14.) 800 w.

†21244. Labor Representation. Fred Hammill (F R-April.) 5000 w.

†21245. The Insignificance of the Trades Union Vote. Frederick Wicks (N C-April.) 4800 w.

*21283. Arbitration in Labor Disputes. Editorial (E-April 6.) 2000 w.

*21296. The Forty-Eight Hour Week in Sunderland and in Manchester. Editorial (Eng L-April 6.) 2000 w.

*21315 Employer's Liability in Germany. Percy Wyndham (C G-April 6.) 4000 w.

†21321. The Riddle of the Sphinx.—Shall it be Thought Out or Fought Out? Arthur Withy (W R-April.) 4400 w.

†21324. The Victims of Industry. Charles Rolleston (W R-April.) 5400 w.

*21420. I. Necessity of State Aid to the Unemployed. Stanton Coit. II. The Dangerous Absurdity of State Aid. D. McG. Means (F-May.) 8400 w.

*21490 A Living Wage. J. E. C. Munro (I & S-April 14.) 1800 w.

21586. The History of a Strike (B J C-April 28.) 1200 w.

*21603. A Living Wage. Lord Masham (From the Leeds Mercury.) (I & S-April 21.) 2800 w.

21674. The Aftermath of Strikes. Editorial (A S-April 28.) 600 w.

21755. The Wages Question (B J C-May 5.) 900 w.

*21757. New Light Upon Old Difficulties (J G L-April 24.) 2000 w.

†21865. The Ethics of Dynamite. Auberon Herbert (C R-May.) 10500 w.

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21496. A City Garden (G & F-April 25.) 1400 w.

21538. Hints on the Art of Landscape Gardening. Thomas Hawkes (Sc A S-April 28.) 2000 w.

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21188. The Bahama Expedition of the State University of Iowa. Ill. B. M. Wilson (Sc-A April 14.) 1500 w.

21192. The Political Power of the Sea (Sea-April 12.) 1800 w.

21193. England's Ship-Building Boomerang. Editorial (Sea-April 12.) 1600 w.

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*21297. Liquid Fuel at Sea. Editorial (Eng-L-April 6.) 1650 w.

*21298. What is a Dock? (Tr-April 6.)1200 w.

*21329. American and British Shipbuilding Competition. Editorial (I C T-April 6.) 1400 w.

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*21439. The Proposed Scotch Ship Canal (E-April 13.) 1200 w.

*21441. Water Tube v. Cylindrical Boilers.—Reply to Discussion. James Howden (E-April 13.) 4000 w.

*21443. Stress and Strain in the Structure of Vessels. Ill. T. C. Read and G. Stanbury (E-April 13.) 2000 w.

*21469 Inland Navigation (Eng L-April 13.) 1800 w.

*21474. Tubulous and Cylindrical Boilers for Marine Service. Editorial (I & I-April 13.) 1000 w.

*21602. An American Shipbuilding Yard. (From the Philadelphia Times.) (I & S-April 21.) 2700 w.

*21610. The Currents in the Great Lakes of North America. (Extracts.) Ill Mark W. Harrington (N-April 19.) 2000 w.

21623. Rapid Method of Handling Soft Coal.—Machine for Dumping Coal in Car Loads into Vessels. Ill. (M R C-April 26.) 1300 w.

21717. Shipping and Silver.—Discriminating Duties Proposed for Their Protection William W. Bates (Sea-May 3.) 1200 w.

*21797. Shipbuilding on the Longitudinal Flanged-Girder System. Ill. (Eng L-April 27.) 1800 w.

*21806. The Year's Steaming of the "Campania" and "Lucania" (E-April 27.) 450 w.

†21872. The Mariner's Compass. J. E. Gore (I E-April 7.) 1100 w.

21878. The Fall River Line Steamer "Priscilla" Ill. (Am S-May 10.) 1500 w.

21889 A Shipbuilders' Home.—The Webb Memorial. Ill. (Sea-May 10.) 1500 w.

21890. American Ownership and Use of Foreign Vessels. William W. Bates (Sea-May 10.) 1400 w.

Serials.

16636. Marine Engine Design (M W-Began Oct. 6—8 parts to date—30 cts. each).

20679. Criticism on Mr. Carlile's Article on Water Tube Marine Boilers. E. E. Roberts (Am S-Began March 22—4 parts to date—15 cts. each).

21300. Vessels for the Bulk Oil Trade (A M & I W-Began April 13—Ended April 20—2 parts—15 cts. each).

21879. Water Tube Boilers.—Reply to Criticism. W. A. Carlile (Am S-Began May 10—1 part to date—15 cts).

MECHANICAL ENGINEERING

21184. Power Required to Drive Machine Tools. J. J. Flather (A M-April 12.) 1200 w.

21186. Early American Steel Rules. Ill. Ambrose Webster (A M-April 12.) 800 w.

21190. The Relation of Machinery to Commercial and Industrial Depression. (Reprint from N. Y. Sun.) (Sc A S-April 14.) 3000 w.

21216. Modern Type Composition.—Leading Features of the Merganthaler, Rogers and Monoline Line Casting Machines. Ill. (I Age-April.) 5000 w.

21234. Designing Machinery —The Importance of a Knowledge of Principles (B J C-April 14.) 600 w.

*21281. Point Paths in Mechanisms: A Contribution to Elementary Kinematics. Ill. (E-April 6) 3500 w.

*21282. Pressed Steel Underframes. Ill. (E-April 6.) 3400 w.

*21293. "On a Flu'd Pressure Reversing Gear." Ill. David Joy (Eng L-April 6.) 1700 w.

*21308. Grinding Tools. Ill. (I C B-April 6.) 3800 w.

21340. Automatic Adjustments for Bearings. (Abstract.) Ill. W. A. McWilliam (S V-April 15.) 1100 w.

21359. Tool Dressing. Ill. B. F. Spalding (A M-April 19.) 2800 w.

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21361. The Schiele Curve. Wilfred Lewis (A M-April 19.) 1800 w.

21363. Laying Out Patterns for a Blast Pipe. Ill. George Guntz (A M-April 19) 1300 w.

21374. Shops of the Walter A. Wood Harvester Company, at St. Paul, Minn. Ill. Tracy Lyon (E N-April 19.) 1600 w.

21381. Testing Machines and Tests of Materials. (Abstract.) Ill. Tinius Olsen (E N-April 19.) 2700 w.

*21428. The Great Wheel. Some Interesting Particulars to the Details. Ill. (M-April 15.) 1500 w.

*21436. Petroleum Engines. William Robinson (E-April 13.) 2800 w.

21465. Notes on Rope Driving. Joseph Nasmith (M G-April 21.) 1500 w.

*21502. The Factor of Safety. John H. Barr (S J E-April.) 2400 w.

21510. Creosoting Works of Ricker, Lee and Company, Galveston, Tex. Ill. (E N-April 12.) 900 w.

21536. Notable and Curious Watches. Ill. (Sc A-April 28.) 1200 w.

21701. Transmission of Power by Friction Pulleys. Ill. (Sc A S-May 5.) 1800 w.

21706. Beauty in Machine Design (Ir Age-May 3.) 1300 w.

†21725. Coal Handling Apparatus at the Southern Station of the Brooklyn City Railway. Ill. (S R J-May.) 1500 w.

†21759. The Bar-Lock Type-Writer. Ill. (J F I-May.) 2000 w.

*21787. American Tacks (I C B-April 27.) 2200 w.

21789. Shuman's Process and Apparatus for Embedding Wire Netting in Glass. Ill. (S M-May 1.) 3500 w.

*21794. Briquette Making Machinery. Ill. Invention of Robert Middleton (I S C-April 27.) 1300 w.

*21817. Reclamation Machinery on the Pacific Coast. Ill. (I S F-May.) 1700 w.

21858. About Emery Wheels. O. S. Walker (A M-May 10.) 800 w.

21860. The Polar Planimeter. William Cox (A M-May 10.) 1300 w.

21883. Lubrication (Sc A S-May 12.) 1800 w.

21884. Waste Energy. George Hill (From Cassier's Magazine) (Sc A S-May 12.) 1800 w.

Serials.

16781. Rope Driving. Ill. J. J. Flather (E W-Began Oct. 26—11 parts to date—15 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7—8 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1—12 parts to date—30 cts. each).

19802. Mechanical Refrigeration. R. C. Carpenter (S J E-Began Feb.—3 parts to date—30 cts. each).

20171. Practical Notes on Rope Driving. M. E. (S R J-Began March—2 parts to date—45 cts. each).

20900. Mechanical Drawing—Elementary Hints for Shopmen. Ill. (T-Began April 1—3 parts to date—15 cts. each).

21115. On an Overhead Power Travelling Crane. Ill. George Russell (M W-Began March 30—Ended April 13—2 parts—30 cts. each).

21473. The Difficulties, Design and Economical Working of Dust Destructors (I & I-Began April 13—1 part to date—30 cts).

21762. Emery and Other Abrasives. T.

Dunkin Paret (J F I–Began May—1 part to date —45 cts).

21818. Systems of Piece Work (I S F–Began May—1 part to date—30 cts).

21819. On the Transmission of Power. A. E. Chodzko (I S F–Began May—1 part to date —30 cts).

METALLURGY.

*21155. The Science of Electro-Metallurgy. Alfred E. Hunt (E Mag–June) 3000 w.

21187. Foundry Mixtures Controlled by a Mechanical Analysis. W. J. Keep (A M–April 12.) 3800 w.

*21198. The Iron Ore Measures of County Antrim. G. H. Kinahan (I C T–Feb. 23.) 2000 w.

21225. All About Aluminum (I I G–April.) 1000 w.

21262. The Tierra Seca Gold Separator. Ill. (E M J–April 14.) 1200 w.

*21319. Sulphurous Coke. Walter J. May (Inv–April 7.) 500 w.

*21345. An Interesting Electro-Chemical Gold-Extracting Process (A M S–March 3.) 800 w.

21362. Crucible Furnace for Burning Petroleum. Ill. W. E. Crane (A M–April 19.) 500 w.

*21413. Iron and Metal Work in India (M W–April 13.) 1200 w.

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21448. German Iron-making and its Residual Products (E M J–April 21.) 800 w.

21466. A Green Sand Job. Ill. Henry Hansen (F D–April 10.) 1500 w.

21467. The Old School: Does It Pay? Thomas D. West (F D–April 10.) 1600 w.

21468. Malleable Iron Castings.—The Process of Their Manufacture Explained, Including Annealing, Practical and Theoretical. S. Bolland (F D–April 10.) 3300 w.

*21489. Notes on the Designing of Metallic Structures. O. J. Marstrand (G W–April 14.) 1800 w.

†21553. The Magnetic Concentration of Iron Ores. Edward K. Landis, with Discussion (P E C P–Jan.-March.) 4000 w.

21558. Method of the Capillary Electrolytic Sluice in the Extraction of Gold. J. H. Jory (M S P–April 21.) 900 w.

21583. Loss of Iron by Remelting and Slagging. Thomas D. West (I T R–April 26.) 3500 w.

21596. Segregation in Iron and Steel. Ill. (E M J–April 28.) 1200 w.

21597. The Economic Uses of Blast Furnace Slag. A. D. Elbers (E M J–April 28. 1800 w.

21598. The Diamond in the Cañon Diablo Meteoric Iron. George F. Kunz and O. W. Huntington (E M J–April 28.) 1000 w.

21715. Practical Blacksmithing. James F. Hobart (T–May 1.) 3200 w.

*21751. American Steel Works (E Rev–April 20.) 1200 w.

21825. Study of a Modern Iron and Steel Plant. Ill. G. L. Luetscher (A M & I W–May 4.) 2700 w.

21857. Hardening and Smithing Processes. Ill. B. F. Spalding (A M–May 10.) 2500 w.

21859. Late Experiments Approaching "Center Blast." Ill. Thomas D. West (A M–May 10.) 1400 w.

21861. A Case of Small Pattern Work. Ill. John M. Richardson (A M–May 10.) 850 w.

Serials

19145. Cupola Management. Edward Kirk (Met W–Began Jan. 27—11 parts to date—15 cts. each).

19215. Canadian Iron Industry. George E. Drummond (C Eng–Began Jan.—Ended April —4 parts—15 cts. each).

21201. Lacquer and Bronze Work. William Norman Brown (Pl D–Began April—1 part to date—30 cts).

21212. Venting. Ill. S. Bolland (M W–Began April 6—Ended April 13—2 parts—30 cts. each).

21330. Steel and Its Manufacture. Henry Webb (I S C–Began April 6—1 part to date—30 cts).

21369. Press Work of Sheet Metals. Ill. Oberlin Smith (Ir Age–Began April 19—1 part to date—15 cts.).

21491. Wrought Iron Work: Mediæval and Modern. J. Starkie Gardner (B A–Began April 13—3 parts to date—30 cts. each).

21557. American vs. European Basic Bessemer Steel. J. B. Nau (Ir Age–Began April 26—Ended May 3—2 parts—15 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng–Began April 27—1 part to date—30 cts.).

MILITARY ENGINEERING.

†21165. The Bogus Apotheosis of the British Army. Archibald Forbes (C R–April.) 5200 w.

*21290. Why Not a Strong Channel Squadron? Editorial (I & I–April 6.) 1200 w.

21342. The Process of Manufacturing Cast Iron Cannon. Ill. (S V–April 15.) 1200 w.

*21393. The Naval Defences of the Country (Abstract) J. Howard Biles (E G–April.) 2600 w.

*21424. Louis Kossuth. Ill. (R of R–April 16.) 10000 w.

*21437. The Navy Estimates. Editorial (E–April 13.) 2800 w.

†21527. England in the Mediterranean. P. H. Colomb (N A R–May.) 5000 w.

21534. A Mediæval Ironclad. Ill. (Reprint from London Graphic.) (Sc A–April 28.) 700 w.

21574.—75 cts. Coast Defense Including Submarine Mines. Henry L. Abbot (J M S I–May.) 6500 w.

21575.—75 cts. The Outlines of a South American Revolution. James H. Sears (J M S I–May.) 10500 w.

21576.—75 cts. The Transport of Troops and Supplies. S. B. Holabird (J M S I-May.) 3500 w.

21577.—75 cts. Infantry Footwear. N. P. Phister (J M S I-May.) 4200 w.

21578.—75 cts. The Military Hand Litter. Ill. John Van R. Hoff (J M S I-May.) 4500 w.

21579.—75 cts. Hints on Training and Instructing Drivers for Field Artillery. Eli D. Hoyle (J M S I-May.) 3000 w.

21624. Auxiliary Machinery of a Modern Cruiser (M R C-April 26.) 2500 w.

*21641. The Naval Programme. Editorial (E-April 20.) 2800 w.

†21665. Capture of the Slave Ship "Cora." The Last Slaver Taken by the United States. Ill. Wilburn Hall (C M-May.) 10500 w.

21731. The Carnegie Steel Company's Armor Plate Frauds, with Editorial (R E M-May.) 3600 w.

*21801. The Re-armament of Our Early Ironclads. Editorial (Eng. L-April 27.) 1500 w.

†21864. Disarmament. Jules Simon (C R-May.) 3700 w.

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20068. The Future of Naval Warfare. H. Middleton (Inv-Began Feb. 17—Ended April 7—6 parts—30 cts. each).

20214. A General Review of Existing Artillery. Gaston Moch (J M S I-Began March—2 parts to date—75 cts. each).

21358. The First War Steamer of the World.—The Fulton. Ill. (Sc A S-Began April 21—1 part to date—15 cts).

21582. The New Regulations for Field Fortification in the German Army. Ill. Thomas C. Patterson (J M S I-Began May—1 part to date—75 cts.)

MINING.

*21162. Gold-Dredging in New Zealand. Thomas A. Richard (E Mag-June.) 3000 w.

21170. A Surveyor's Observations and Opinions. L. V. Rorke (C Eng-April.) 2200 w.

21183. Origin of Gold Nuggets. Arthur Lakes (M I T-April 5.) 1300 w.

21199. Auriferous Beaches of New South Wales (M S P-April 7.) 1300 w.

21215. Another Lawless and Bloody Outbreak in the Connellsville Region (B I S-April 11.) 1500 w.

21236. Georgia Gold Mines. Garrard Harris (M R-April 13.) 1800 w.

21249. The Marble Industry in East Tennessee. H. V. Maxwell (T-April 15.) 1200 w.

21253. The Growth of the Southern Coal Mining Interests. J. T. Hill (T-April 15.) 2700 w.

21261. The Russian Gold Mining Industry (E M J-April 14.) 2500 w.

21263. The Mineral Industry of Greece. E. Grohmann (E M J-April 14.) 1000 w.

21299.—25 cts. Coal—A Description of the Fields of the United States and Canada, with Reference to the Atlantic and Pacific Seaboards, with Statistics of Production, Labor, Wages, etc. Joseph D. Weeks (A M & I W-April 13.) 19000 w.

*21312. Freeing from Water and Guiding the Pisani Shaft, Trelys Colliery, France. Léon Delafosse (C G-April 6.) 3800 w.

*21314. The Asbestos Fields of Port au Port, Newfoundland. C. E. Willis (C G-April 6.) 1400 w.

*21317. Pneumatic Sinking. Arnold Lupton (C G-April 6.) 1400 w.

*21328. Cast-Iron Tubbing in the Shafts at Sydney Mines, Cape Breton. R. H. Brown (I C T-April 6.) 1500 w.

*21343. The Silver Crisis—How It Affects the Broken Hill Proprietary Mine (A M S-Feb. 24.) 2000 w.

*21346. The West Coast (Tasmanian) Nickel Mine. G. H. Beardsley (A M S-March 3.) 800 w.

*21351. A New Goldfield for New South Wales—A Big Rush to Wyalong (A M S-March 17.) 1300 w.

21382. Gold Mines of Southern Oregon. Alex Quartz (M S P-April 14.) 1100 w.

†21402. Coal Workers—Bengal Coal Mine. Ill. (I E-March 17.) 700 w.

21409. Ten-Mile Coal and Coke Company. Thomas Bruce (M R-April 20.) 1800 w.

21446. The Phosphate Beds of Tennessee. J. M. Safford (E M J-April 21.) 800 w.

*21462. Hurd's Pneumatic Electric Coal-Cutting Machine. (Abstract.) Joseph Crankshaw (C G-April 13.) 2000 w.

21504. Do Ores Grow Richer or Poorer, More or Less Plentiful, in Depth—or Is There Any Rule? (M I T-April 19.) 2000 w.

†21540. Rubber Belts for Ore-Concentration in Mining. Ill. Albert Williams, Jr. (I R W-April 15.) 2500 w.

21560. Gold Mining in Georgia. E. T. Whatley (M R-April 27) 1500 w.

21584. Cerrillos, New Mexico—The Center of a Great Mining District (Min R-April 19.) 1800 w.

21655. The Miners' Strike, with Editorial (A M & I W-April 27.) 2500 w.

21673. Our Coal Industry. Editorial (A S-April 28.) 500 w.

21713. Mineral Lands in the South—The Necessity of Developing Them and How It Can Be Accomplished. W. M. Brewer (T-May 1.) 1900 w.

21714. The Georgia Gold Belt. A. A. Bowie (T-May 1.) 1400 w.

†21767. The Iron Ores of the Mesabi Range. J. E. Spurr (A G-May.) 3500 w.

*21778. The Lucknow Mines (I & S-April 28.) 2000 w.

*21779 The Eight Hours Bill for Miners—

Objections of the North of England United Coal Trade Association (I & S-April 28.) 1600 w.

*21780. Gold Mining in Australia. John Plummer (I & S-April 28.) 800 w.

*21800. Coal and Conciliation. Editorial (Eng L-April 27.) 1650 w.

*21810. Collieries Round Gelsenkirchen, Rhenish Westphalian Coalfield (C G-April 27.) 2800 w.

21820. The Amy and Silversmith Decision. R. W. Raymond (E M J-May 5.) 1800 w.

21822. Origin of the Iron Pyrites Deposits in Louisa County, Virginia. Ill. Frank L. Nason (E M J-May 5) 3500 w.

21823. The Phosphate Rocks of Tennessee. Ill. William B. Phillips (E M J-May 5.) 1400 w.

*21836. Underground Stoppings—Built to Isolate the Dangerous Portions of a Coal Mine. Ill. E. B. Wain (C E-May.) 1800 w.

*21837. Prospecting for Gold in Africa—An Article describing the occurrence of Gold and Silver in the South African Gold Fields, and the methods adopted in working them. Ill. Arthur Lakes (C E-May) 3000 w.

*21839. Ventilating Fans for Mines. J. T. Beard (C E-May.) 4800 w.

*21841. Stadia Surveying in Field and Office. Charles Oldknow (C E-May.) 2200 w.

*21842. Spontaneous Combustion in Coal Mines (C E-May.) 1800 w.

21856. Chemical Theories About Formation of Nuggets. Arthur Lakes (M I T-May 3) 900 w.

21866. Cochiti District (Min R-May 3.) 900 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E-Began Jan., 1893—16 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March, 1893—Ended May, 1894—14 parts—30 cts. each).

19682. The Sinking and Equipment of Shafts. Ill. (E-Began Feb. 2—4 parts to date—30 cts. each).

19919 North Queensland Goldfields (A M S-Began Jan. 6—7 parts to date—30 cts. each).

20223. The Cumberland Coalfield. M. E. (C G-Began Feb. 23—6 parts to date—30 cts. each).

20407. Mine Surveying.—Methods Employed in the Coal Fields of Pennsylvania. Otto C. Burkhart (C E-Began March—3 parts to date—30 cts. each).

20413. Mining Methods. Ill. (C E-Began March—3 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—3 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C. E-Began March—3 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—3 parts to date—30 cts. each).

21313. The Lancashire Coalfield. M. E. (C G-Began April 6—4 parts to date—30 cts. each).

21344. West Australian Mining Law (A M S—Began March 3—2 parts to date—30 cts. each).

21444 The Mineral Industry of Tasmania (E M J-Began April 21—Ended April 28—2 parts—15 cts each).

21460. The Rhenish-Westphalian Coalfield. Leo Cremer and Richard Cremer (C G-Began April 13—Ended April 20—2 parts—30 cts. each).

RAILROADING.

*21160. The Present and Future Locomotive. Ill. David L. Barnes (E Mag-June.) 3000 w.

21226. The Abolition of Grade Crossings in Brockton, Mass. Ill. (R G-April 13.) 2000 w.

21228. The High-Speed Brake. Editorial (R G-April 13.) 1600 w.

21229. Judge Caldwell's Decision. Editorial (R G-April 13.) 1600 w.

21230. The Right to Break Bulk. Editorial (R G-April 13.) 1700 w.

21232. The Problem of the Counterbalance (R G-April 13.) 400 w.

21274. Decisions of Judge Jenkins and Judge Caldwell, with Editorial (R A-April 13.) 4200 w.

21331. The Southern Railway and Steamship Association. Manufacturer and Editorial (R R-April 14.) 2000 w.

21333. The Selection of Traveling Engineers. Editorial (R R-April 14) 1800 w.

21334. The Economics of Transportation. H. S. Haines (R R-April 14.) 2600 w.

21384. Railroad Switching and Yards (Abstract) E. K. Turner (R G-April 20.) 800 w.

21385. The Value of Tie Plates in Track Repairs (R G-April 20.) 1200 w.

21386. The New C. H. and D. Freight House at Cincinnati (R G-April 20.) 700 w.

21387. Air-Brakes and Freight Train Speed. Editorial (R G-April 20) 700 w.

*21390. Relative Cost of Steam, Compressed Air and Electricity for the Operation of Railroads. Herman Haupt (S R R-April 15.) 3200 w.

*21391. Relative Cost of Steam and Electricity for the Operation of Railways. W. E. Baker (S R R-April 15.) 1800 w.

21419.—$1.50. Train Loadings for Railroad Bridges, with Discussion. Ill. Theodore Cooper (T C E-Feb.) 16800 w.

*21422. Railroading as a Career. Brandt Mansfield (Ch-May.) 3300 w.

*21434. Otis Elevating Railway, Catskill Mountain, Greene County, New York. Ill. (E-April 13.) 2800 w.

*21435. Rack Rail Locomotive (Lange and Livesey's System) for the Puerto Cabello and Valencia Railway. Ill. (E-April 13.) 1200 w.

*21455 The Severn and Wye and Severn Bridge Railway (Tr-April 13.) 700 w.

*21488. Pneumatic Railways. Ill. G. A. Sekon (P Eng–April 13.) 3200 w.

21497. Iron Freight Cars. (Abstract) E. C. Spalding (R A–April 20.) 2000 w.

21499. Coupler Tests. Editorial (R R–April 21.) 1100 w.

21535. The Park Avenue Improvement in New York City. Ill. (Sc A–April 28.) 1400 w.

21562. Preservation of Ties and Timber on the Southern Pacific Railway (E N–April 26.) 1500 w.

21563. The Train Staff and Tablet Systems for High Speed Train Service. Ill. (E N–April 26.) 2200 w.

21565. Track Elevation, Lake Shore and Rock Island Railways, Chicago (E N–April 26.) 1000 w.

21566. Accidents to Postal Cars (E N–April 26.) 1800 w.

21568. Handling Air-Braked Trains (R G–April 27.) 3500 w.

21569. The Relation of Wheels to Frog Points and to Guard Rails. (Abstract.) Archibald A. Schenck (R G–April 27.) 2000 w.

21571. The Use of Small Anthracite for the Prevention of Smoke. Editorial (R G–April 27.) 1200 w.

21572. Another Central African Railroad (R G–April 27.) 1200 w.

21573. How to Instruct Trainmen and Inspectors about Air-Brakes. F. M. Nellis (R G–April 27.) 4300 w.

21594. The Decision in the Northern Pacific Strike Cases, with Editorial (E M J–April 28.) 2800 w.

*21642. The International Railway Congress. Editorial (E–April 20.) 1700 w.

*21650. The Great Northern Lines in Yorkshire. Ill. (Eng L–April 20.) 800 w.

*21651. Train Resistances.—English and American. Editorial (Eng L–April 20.) 1600 w.

21658. The Immigrant Rate War. Editorial (R A–April 27.) 550 w.

†21667. A Revolutionary Railway Company. Albert Griffin (A–May.) 3500 w.

21670. Four-Cylinder Compound Locomotives of the Hungarian State Railway. Ill. (R R–April 28.) 2500 w.

21671. Which Policy Best for State Railroad Commissions—Arbitra y or Advisory? (R R–April 28.) 2500 w.

21672. Air-Pump Repairs. Otto Best and C. A. Sanders (R R–April 28.) 2300 w.

*21683. Uneven Performance of Locomotives. Editorial (L E–May.) 2000 w.

*21684. A Bit of Railroad Geometry. John H. Cooper (L E–May.) 1500 w.

*21685. Air-Brake Peculiarities. Will W. Wood (L E–May.) 1800 w.

*21688. Care of Passenger Trains at Terminals. E. A. Williams (N C B–May.) 1300 w.

*21689. Locomotive Boiler Tubes.—Removing Tubes and Scale. Ill. James F. Hobart (N C B–May.) 1200 w.

21721. The Efficiency of Air and Foundation Brakes. Waldo H. Marshall (E N–May 3.) 3000 w.

21722. Tests of Punches of Different Forms. Ill. George S. Allen (E N–May 3.) 1800 w.

21732. The Design and Material for Driving Boxes (R E M–May.) 1000 w.

21740. Short or Long Smoke-boxes.—Letters and Editorial. Ill. (R G–May 4.) 4000 w.

21741. Cleaning and Oiling Triple Valves and Brake Cylinders.—Report of Air-Brakemen's Convention (R G–May 4.) 2700 w.

21742. The Progress of Railroad Reorganization. Editorial (R G–May 4.) 1700 w.

*21748. Corliss Valves on Locomotives. Ill. (M W–April 27.) 1400 w.

*21750. Rail Fastenings for Metal Sleepers. Herr Banovit's System. Ill. (E Rev–April 20.) 1500 w.

21768. Hygienic Conditions Necessary for the Transportation of Persons Ill with Infectious and Contagious Diseases. G. P. Conn, with Editorial (R A–May 4.) 5300 w.

21769. A Great Railway Museum. The Permanent Collection of Transportation Appliances and Curiosities at Jackson Park. Ill. (R A–May 4.) 1200 w.

21770. Rules of Interchange—Recommendations of Central Railway Club (R A–May 4.) 1800 w.

21824. Elevated Railroad Water Pipes and Frost Protection System in Chicago. Ill. (E R–May 5.) 1400 w.

21828. Chicago and St. Louis Electric Railroad. Ill. (S R G–May 5.) 1300 w.

21832. Railroad Names. John T. Bramhall (R R–May 5.) 1800 w.

21833. A Point Gained for Shippers. Editorial (A S–May 5.) 800 w.

21850. Maintenance and Repair of Air-Brakes. Elmer E. Chain (R C J–May.) 1800 w.

21881. The Bicycle Upon Rails. Ill. (Sc A–May 12.) 700 w.

21882. The Tubular Railway of Paris. Ill. (Sc A S–May 12.) 1300 w.

21895.—$1.50. Spirals and Their Use on Railroads. A. S. C. Würtele (T C E–March.) 1800 w.

21897.—$1.50. The Renewal of the Channel Pier of the Cincinnati and Muskingum Valley Railway Bridge over the Scioto River. Ill. Morton L. Byers, with Discussion (T C E–March.) 3000 w.

Serials.

9254. Railway Management. Horace Cope (R R–Began Dec. 31, 1892—12 parts to date—15 cts. each).

12001. Rails on the Creep. A. Ewbank (I E–Began March 11, 1893—45 parts to date—45 cts. each).

17826. Evolution of the Air Brake. Paul Synnesvedt (R E M–Began Dec.—6 parts to date—15 cts. each).

18225. Experiences of a Superintendent. C.

P. Young (S R R-Began Dec.—4 parts to date —30 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan.—4 parts to date—15 cts. each).

18957. Ventilation of Passenger Cars. Ill. James F. Hobart (R C J-Began Jan.—Ended May—5 parts—15 cts. each).

20611. The Mont Salève (Geneva) Electric Rack Railway. Ill. C. S. Du Riche Preller (E-Began March 9—Ended April 20—4 parts—30 cts. each).

20892. Signal Apparatus in Use on the Grand Central Railway of Belgium. Ill. Leopold Kirsch (A E R J-Began April—2 parts to date —30 cts. each).

21498. Bills of Lading. Viator (R R-Began April 21—3 parts to date—15 cts. each).

21679. The Reciprocating Parts of a Locomotive. Ill. F. J. Cole (A E R J-Began May —1 part to date—30 cts.)

STREET RAILWAYS.

21167. The Brand Conduit Railway System. Ill. (E R N Y-April 11.) 500 w.

21222. Electrical Signal System for Cable Railways. Ill. (E A-April 14.) 1200 w.

21223. Electrically Operated Elevated Railroad Bridge. Ill. (W E-April 14.) 800 w.

*21265. Light Electric Railways. Editorial (El-April 6.) 1650 w.

21383. New Tunnel of the West Chicago Street Railway Company. Ill. R G-April 20.) 900 w.

*21388. Electrics in the Crescent City. Ill. (S R R-April 15.) 3800 w.

*21392. An Important Interurban.—Johnstown, Gloversville and Fonda. Ill. (S R R-April 15.) 1200 w.

*21480. Electric Traction. E. F. Bamber (N-April 12.) 2000 w.

21520. Suggestions for Transit Systems. Ill. S. D. Mott (E W-April 28.) 600 w.

21545. Cities and Street Railroad Companies —Their Mutual Relations. Ill. H. H. Carter (G R-April) 3000 w.

*21628. Mechanical Tramway Traction: Compressed Air or Electricity. Ill. Victor Popp (E E L-April 20.) 4000 w.

*21690. Madras Electric Railway Begun. Ill. (S R R-March 15.) 800 w.

*21691. A Graphic Method of Superintendency (S R R-March 15.) 1000 w.

*21692. Long Distance Transmission by Continuous Currents. Ill. F. Boissonnas (S R R-March 15.) 1800 w.

*21693. Performance of Modern Motor Equipments (S R R-March 15.) 1000 w.

*21694. Electricity in Anaconda, Montana. Ill. (S R R-March 15.) 900 w.

*21695. Rapid Transit in New York.—A Solution of the Problem.—The Moving Sidewalk. Ill. (S R R-March 15.) 500 w.

21700. The Luhrig Gas Motor Car. Ill. (Sc A S-May 5.) 1500 w.

21724. Present Utility of Electric Motors on Railways. David L. Barnes (E N-May 3.) 3800 w.

†21726. The Isle of Man Tramways. Ill. (S R J-May.) 1500 w.

†21728. New Orleans, Galveston and Houston. Ill. (S R J-May.) 11500 w.

21730. Novel Construction for an Elevated Electric Railroad.—Tunneling Through Buildings. Ill. (W E-May 5.) 700 w.

*21746. The Genoa Electric Tramways. Ill. (R W-April.) 1500 w.

21851. The Overhead Trolley in New York City.—Completion of the One-Hundred-and-Thirty-fifth Street Line. Ill. (E R N Y-May 9.) 800 w.

Serials.

18549. The Intrinsic Value of Street Railway Investments. Edward E. Higgins (S R J-Began Jan.—5 parts to date—45 cts. each).

18711. Electric Railway Motors: Their Construction and Operation. Nelson W. Perry (S R G-Began Jan. 6—17 parts to date—15 cts. each).

21260. Electric Traction. C. H. Wilkinson (E P-Began April—1 part to date—30 cts).

21747. Steam Tramway Locomotives. Ill. H. Conradi (R W-Began April—1 part to date —30 cts).

21870. A Steam Tramway as a Feeder Line. C. B. Target (I E-Began April 7—1 part to date —45 cts).

SANITARY ENGINEERING.

*21200. Sanitation in Paris. (Pl D-April 2.) 1400 w.

*21306. Technical Museums and Sanitation. De Courcy Meade (A L-April 6.) 3500 w.

21379. Lessons from the Typhoid Epidemic at Montclair, N. J. (E N-April 19.) 1500 w.

21398. Novel Sewer Experiment. Hubert Heywood (F W-April 21.) 1300 w.

*21416. The Plumber's Essay. John Troland (D E-April.) 2800 w.

*21417. Sanitation in the House. Robert Morgan (D E-April) 2000 w.

*21478. A City's Health and How It Is Preserved. Peter Fyfe (S R-April 14.) 8200 w.

*21479. Prof. V. Babes on the Position of the State in Respect to Modern Bacteriological Research. (N-April 12.) 5000 w.

*21524. Sewage Disposal Works, Canton, O. Ill. (J A E S-Feb.) L. E. Chapin.

†21525. A National Health Bureau. George M. Sternberg (N A R-May.) 1800 w.

*21552. Restriction and Prevention of Dangerous Communicable Diseases from the Standpoint of the Health Officer and Physician. Frank M. Gier (A H-May.) 2200 w.

*21619. Roman Baths (I C B-April 20.) 1500 w.

*21620. Simple Sanitation (I C B-April 20.) 950 w.

*21635. Scavenging and Disposal of Refuse. Charles Mason (S R-April 21.) 5000 w.

*21711 Methods of Sewer Construction, Watertown, N. Y. Ill. Fred E. Avery (P-May.) 1000 w.

21756. The Self Purification of Rivers. Charles V. Chapin (S C-March 23.) 1600 w.

*21773. Electrical Sanitation. Ill. (E R L -April 27.) 3500 w.

*21804. Sanitation in India. Editorial. (E -April 27.) 3000 w.

*21807. The Heating and Ventilation of the Houses of Parliament. (B A-April 27.) 1500 w.

Serials.

14839. Water Purification in America. Ill. (E N-Began Aug. 3—9 parts to date—15 cts. each).

19132. The Metropolitan Sewerage System of Massachussetts. Ill. (E N-Began Jan. 25 —3 parts to date—15 cts. each).

19813. American Plumbing. Ill. (D E-Began Feb.—3 parts to date—30 cts. each).

21132. Sanitary Law. A. Wynter Blyth (I C B-Began March 30—2 parts to date—30 cts. each).

STEAM ENGINEERING.

21185. Combining Indicator Diagrams from Compound Engines. Ill. Frank H. Ball (A M-April 12.) 1100 w.

21220. Origin and Development of Steam Navigation. George H. Preble (From United Service Magazine) (Eng-April 14.) 2500 w.

21233. Buying Steam Boilers.—Why the Best Should be Obtained (B J C-April 14.) 900 w.

21246. Economy in Steam Generation. J. C. McMynn (E E-April.) 650 w.

21250. The Need and the Advantage of Feed-Water Heaters. W. H. Wakeman (T-April 15.) 2000 w.

21251. Improvement in Steam Engineering as Related to Southern Progress in Manufacturing. Leicester Allen (T-April 15.) 1200 w.

*21267. Heat Economizers. Sydney H. Hollands (P Eng-April 6.) 3000 w.

*21327. Oil and Petroleum Engines (Abstract) H. M. Waynforth (I C T-April 6.) 4000 w.

21335. The Edson Pressure Recording Gauge Receives the John Scott Legacy Medal and Premium. Ill. (E R N Y-April 18.) 900 w.

21341. The Economical Use of Soft Coal. Henry Bland (S V-April 15.) 1100 w.

21406. Some Boiler Notes.—Clogged Water Column and a Bagged Sheet (B J C-April 21.) 900 w.

21407. Ratio of Heating Surface to Grate Surface in Boilers (B J C-April 21.) 900 w.

21585. The De Laval Turbine.—A Wheel that Spins at the Rate of 30000 Revolutions a Minute (B J C-April 28.) 900 w.

*21652. Liquid and Solid Fuel Supplies. Editorial (Eng L-April 20.) 1600 w.

*21653. A Thermodynamic Puzzle. Editorial (Eng L-April 20.) 1800 w.

21657. Steam Boiler Trials.—The Youths' Companion Building, Boston (M G-April 28.) 1000 w.

21676. Effect of Steam Bubbles on Circulation. Ill. (P S-May.) 1800 w.

21677. Economy in Compound Engine Plants. Samuel M. Green (P S-May.) 1200 w.

21678. Smoke Prevention (P S-May.) 800 w.

21704. The New Porter Steam Engine. Ill. (Ir Age-May 3.) 4500 w.

*21753. A New System of Smoke Absorption or Suppression. Ill. (Inv-April 14.) 1500 w.

21754. Cylinder Condensation.—The Effect of Rough Surfaces (B J C-May 5.) 1000 w.

21791. Steam Boiler Tests at Youths' Companion Building by Alfred A. Hunting.—Second Trial (M G-May 5.) 450 w.

*21805. Steam on Common Roads (E-April 27.) 3000 w.

21854. The Evolution of the Steam Boiler. J. H. Killey (C E N-May.) 2200 w.

21862. The Compound Engines at the Centennial. Ill. Fred H. Colvin (A M-May 10.) 1400 w.

21863. New and Simple Formulas for Saturated Steam. G. B. Maynadier (A M-May 10.) 650 w.

21891. Results of Boiler Tests Made by the Robert W. Hunt and Company. Table (Ir Age-May 10.) 800 w.

Serials.

13033. Practical Hints to Boiler Makers and Templaters. Ill. (M W-Began May 12, 1893 —9 parts to date—30 cts. each).

16756. Theory of Steam Engine Governors. Ill. J. Begtrup (A M-Began Oct. 19—5 parts to date—15 cts. each).

18169. Power Plant in the Realty Building. Ill. (E R-Began Dec. 16—2 parts to date—15 cts. each).

18986. Boiler Calculations. James F. Hobart (S M-Began Jan. 15—5 parts to date—15 cts. each).

19709. The Indicator and Its Diagrams. Charles Day (P Eng-Began Feb. 2—8 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—3 parts to date—30 cts. each).

20568. The Stationary Engineers as They Were and as They Are. Stephen Roper (S V-Began March 15—Ended April 15—2 parts—15 cts. each).

21064. The Testing of Engines and Boilers. Alexander B. W. Kennedy (El-Began March 30—Ended April 20—2 parts—30 cts. each).

TELEPHONY AND TELEGRAPHY.

21168. Telephone Rates in Europe (E R N Y-April 11.) 1300 w.

21178. The Mercadier and Anizan Microphone Reducer. Ill. (E E N Y-April 11.) 1100 w.

*21258. Sir Henry Mance's Battery Resist-

ance Test in Its Application to Duplex Telegraphy. Ill. (E R L–April 6.) 650 w.

*21259. An Adjustable Microphone. Ill. W. H. Soulby (E R L–April 6.) 800 w.

*21285. Telegraphic Communication by Induction by Means of Coils. Charles A. Stevenson (E–April 6.) 2000 w.

*21302. The Best Resistance for the Receiving Instrument on a Leaky Telegraph Line. Ill. W. E. Ayrton and C. S. Whitehead (E E L–April 6.) 1200 w.

21338. Telephony Without a Wire. Ill. (E R N Y–April 18.) 900 w.

21353. The Postal Telegraph Cable Company's New Building. Ill. (E W–April 21.) 8000 w.

21371. Invention and Development of the Telephone. Ill. Herbert Laws Webb (W E–April 21.) 1200 w.

*21500. Submarine Telegraphy. A. E. Kennelly (S J E–April.) 2000 w.

Serials.

18628. The Electro-Magnet; or Joseph Henry's Place in the History of the Electro-Magnetic Telegraph. Mary A. Henry (E E N Y–Began Jan. 3—12 parts to date—15 cts. each).

MISCELLANEOUS.

*21158. Business Opportunities in Peru. Ill. H. Guillaume (E Mag–June.) 3000 w.

*21161. The Pine Industry in the South. Ill. George L. Fowler (E Mag–June.) 3000 w.

21355. The Utilization of the Waste Energy of the World (Sc A–April 21.) 1100 w.

21394. On the Origin of Ancient Quartz Rocks. J. F. Blake (Sc–March 16.) 1500 w.

*21421. The True Meaning of Farm-Mortgage Statistics. Edward Atkinson (F–May.) 6000 w.

21447. Determination of the Refractoriness of Fire-Clays. Ill. H. O. Hofman and C. D. Demond (E M J–April 21.) 1500 w.

*21471. The Apprentice Question. John Inglis (Eng L–April 13.) 3300 w.

*21503. Notes on the Materials of Aeronautic Engineering. R. H. Thurston (S J E–April.) 4500 w.

21514. The Topographical Survey of New York (E N–April 12.) 1800 w.

†21526. Helping People to Help Themselves. Nathan Straus (N A R–May.) 5000 w.

†21542. The Relation of Rubber-Gathering to Manufacture. Francis Harvey (I R W–April 15) 1800 w.

21544. Denver and Vicinity. Ill. Edward B. Light (G R–April) 1600 w.

21559. Edward Atkinson on Banking (M R–April 27.) 3000 w.

21615. New England Nationalism. Edward E. Hale (B C–April 28.) 5700 w.

†21666. First Principles of the Land Question. Louis F. Post (A–May.) 5000 w.

†21668. The Philosophy of Mutualism. Frank Parsons (A–May.) 13000 w.

21707. Points in Fertilizer Manufacturing. A. D. Ledoux (M R–May 4.) 1800 w.

*21710 The Fusibility of Clays. H. A. Wheeler (P–May.) 1500 w.

*21749. Engineers of To-Day and Yesterday. John Gjers. Ill. (E Rev–April 20.) 1500 w.

†21765. A Reconnoissance of the Abandoned Shore Lines of Green Bay. F. B. Taylor (A G–May.) 4000 w.

†21766. American Species of Autodetus and Some Paramorphic Shells from the Devonian. Ill. John M. Clarke (A G–May) 2500 w.

*21792. Evolution in Decorative Art. Henry Balfour, with Discussion (J S A–April 27.) 10000 w.

*21793. The Face of the Earth. Charles Lapworth (N–April 26.) 3800 w.

*21798. Carnot and Modern Heat.—Criticising Dr. Lodge's paper (Eng L–April 27.) 1500 w.

21873. A Botanic Garden for New York (G & F–May 9.) 900 w.

21886. Isoperimetrical Problems. Lord Kelvin (Sc A S–May 12.) 3000 w.

Serials.

18930. Carnot and Modern Heat. Dr. Oliver Lodge (Eng L–Began Jan. 5—11 parts to date—30 cts. each).

20802. Measurement of High Temperatures. Ill. A. Humboldt Sexton (P Eng–Began March 23—3 parts to date—30 cts. each).

21067. Geological Notes on the Sierra Nevada. H. W. Turner (A G–Began April—Ended May—2 parts—45 cts. each).

21269. Aerial Flight: the Steering of Balloons. Ill. (P Eng–Began April 6—Ended April 13—2 parts—30 cts. each).

21450. Evolution in Decorative Art. Henry Balfour (A L–Began April 13—Ended April 20—2 parts—30 cts. each).

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21518. The Mid-Winter Fair. Ill. (E W–Began April 28—3 parts to date—15 cts. each).

21591. The Preservation of Wood. A. M. Villon (E R–Began April 28—1 part to date—15 cts).

21763. Engineering Practice and Education. Gaetano Lanza (J F I–Began May—1 part to date—45 cts).

21816. The Waste Lands of Australia. Ernest Favenc (A P R—Began March—1 part to date—45 cts).

THE·TECHNICAL·INDEX

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THIS index has been very properly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings, that within a few minutes, once a month, an active man can learn of everything of any importance that has been published during the month in relation to the subjects in which he is interested. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential improvement—namely: that in addition to indicating *just when and where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. W=Words.]

THE AMERICAN PRESS.

A.....Arena. *m.* $5. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An....American Analyst. *f.* $1. New York.
A Ar....American Artisan. *w.* $2. Chicago.
A & B...Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J P....Am. Jour. of Politics. *m.* $3. New York.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S M E..Am. Soc. of Mec. Eng. *m.* New York.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B D.....The Black Diamond. *w.* $3. Chicago.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C ...Boston Jour. of Commerce. *w.* $3. Boston.
B & W. .Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York
C M R. .Canadian Mining Rec. *m.* $1.50. Ottawa.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $2. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $1. Chicago.
Elek ....Elektron. *m.* $3 Boston
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng.....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .. ....Forum. *m.* $3. New York.

F D.....The Foundry. *m.* $1. Detroit.
F W .....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G R.....Good Roads. *m.* $1. New York.
I A. .....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3 New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S. Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E. Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I. Jour. Milit. Service In. *b-m.* $4. New York.
J N E W. Jour. N.E. Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A. Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L. H. P. Light, Heat and Power. *m.* $3. Phila.
L Mag. Lippincott's Magazine. *m.* $3. Phila.
M & B. Manufacturer and Builder. *m.* $1.50. N. Y.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $3. Boston.
Mill.....Milling. *m.* $2. Chicago.
Min. R. The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Mi N....The Monumental News. *m.* $1. Chicago.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C. Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
N A R. North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B. National Car Builder. *m.* $2. New York.
N E M. New Eng. Magazine. *m.* $3. Boston.
N P R. Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R. Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P..... Paving. *m.* $2. Indianapolis.
P A .. ..Progressive Age. *s-m.* $3. New York.
P E C P. Procd. Engineer's Club. *q.* $2. Phila.
Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
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R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
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R & T...Roofer and Tinner. *m.* $1. N. Y.
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Sc A S ..Scientific Am. Supplement. *w.* $5. N. Y.
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Sc Q.....Scientific Quarterly. *q.* $2. Golden, Cal.
Sea.....Seaboard. *w.* $2. New York.
S Ec.....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *s-m.* $1.50. Cleveland, O.
So L .....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q....School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G ....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E. Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E... Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
Tech ..The Technograph. Champaign. Ill.
T Q.....Technology Quarterly. $3. Boston.
Tr A M E. Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W E.....Western Electrician. *w.* $3. Chicago.

THE FOREIGN PRESS.

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A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
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C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
E.....Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E G.....Engineers' Gazette. *m.* 8*s.* London.
E L.....Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P.....Electrical Plant. *m.* 6*s.* London.
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E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
F R.....Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
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I Eng....Indian Engineer. *w.* 20 Rs. Calcutta.
Inv .. ..Invention. *w.* 11*s.* London.
I S C.....The Iron, Steel and Coal Times. *w.* £1 6*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
M.....Machinery. *m.* 9*s.* London.
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Min W..The Mining World. *w.* 21*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N C.....Nineteenth Century. *m.* $4.50 London.
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R W.....Railway World. *m.* 5*s.* London.
S L.....Steamship. *m* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
Tr.....Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

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Serials.

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*22000. The Cost of Electrical Energy. Editorial (Eng L–May 4.) 2200 w.

*22018. The Transformation of Direct into Alternating Currents and Vice Versa. Ill. (E E L–May 4.) 1600 w.

†22030. Discussion of paper by I. H. Farnham on "The Destructive Effects of Electrical Currents on Subterranean Metal Pipes" (T A I E E–May.) 14500 w.

†22031. Discriminating Lightning Arresters, and Recent Progress in Means for Protection Against Lightning. Ill. Alexander Jay Wurts (T A I E E–May.) 8000 w.

22094. New Form of Carey-Foster Apparatus. W. M. Stine. Ill. (E E–May) 1700 w.

*22133. The Electrical Sub Stations of the Paris Compressed Air Company. Ill. J. Lafargue (E R L–May 11.) 1000 w.

*22134. Alternating Currents and Hysteresis. Arthur Whitwell (E R L–May 11.) 1000 w.

*22135. Cost of Electrical Energy. W. H. Booth (E R L–May 11.) 1000 w.

22169. Review of the Progress of the American Institute of Electrical Engineers. Inaugural Address of Edwin J. Houston (E R N Y–May 23.) 1600 w.

22170. Relative Advantages of Toothed and Smooth Core Armatures. Alton D. Adams (E R N Y–May 23.) 1500 w.

22171. Test of a Closed Coil Arc Dynamo. (Abstract.) Robert B. Owens (E R N Y–May 23.) 1500 w.

*22179. The Electromagnetic Theory of Light. John Trowbridge (Ch–June.) 2500 w.

22226. Picolet's Wimshurst Induction Machine without Sectors. Ill. (Sc A–May 26.) 1000 w.

22358. On the Conditions of Economy in Long Distance Transmission of Power by Electricity. Articles by W. A. Anthony, W. L. K. Emmet, Edwin J. Houston and A. E. Kennelly, F. B. Crocker and C. F. Rittenhouse (E E N Y–May 30.) 4000 w.

22360. Electric Heating from the Engineering Point of View. W. S. Hadaway, Jr. (E E N Y–May 30.) 3000 m.

22362. The Harmonics of Alternating Currents. Ill. Edwin J. Houston and A. E. Kennelly (E W–June 2.) 1500 w.

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†22387. The Nationalization of Electricity. Solomon Schindler (A–June.) 2400 w.

22394. Standardizing Electrical Measuring Instruments. (Abstract.) Elmer G. Willyoung (E N Y–May 30.) 2200 w.

*22451. The Manufacture of Dynamos and Cables — Woolwich Factory (C G–May 25.) 1500 w.

*22476. On the Measurement of the Resistance of Electrolytes. F. J. A. McKittrick (E E L–May 25.) 3000 w.

*22477.—Electricity and Some of its Uses. Ill. Frederick Bramwell (E E L–May 25.) 6000 w.

†22479. On the Damping of Bell-Magnets and Ring-Magnets by Surrounding Copper. Ill. Arthur Kendrick (A J S–June.) 2000 w.

*22484. The Position of the Consumer of Electricity (E R L–May 25.) 1500 w.

*22486. On the Force an Electro-Magnet Exerts on Its Armature. John Hopkinson (El–May 25.) 500 w.

*22489. On the Magnetic Deflection of Cathode Rays. Ill. P. Lenard (El–May 25.) 3200 w.

22518. Alternating Currents and Fuses. Dugald C. Jackson and R. J. Ochsner (E R N Y–June 6.) 2500 w.

*22530. Electric Traction on Common Roads (I & I–May 25.) 900 w.

22550. Electrolytic Methods. A. J. Rogers (E E–June.) 6000 w.

22567. Magnetic Friction and Hysteresis. Charles Proteus Steinmetz (E W–June 9.) 700 w.

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22594. The Electrolysis of Pipes. Editorial (E N–June 7.) 900 w.

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22628. Electric Scenic Theatres in the Masonic Temple, Chicago. Ill. (W E–June 9.) 1600 w.

22631. The National School of Electricity. Ill. (E I–June.) 1600 w.

Serials.

21266. Magnetic Qualities of Iron. Ill. J. A. Ewing and Helen G. Klaassen (El–Began April 6—5 parts to date—30 cts. each).

21396. Coming Developments in Electricity. George D. Shepardson (E A–Began April 21—2 parts to date—15 cts. each).

21744. Electrical Oscillations. Newton Harrison (E A-Began May 5—3 parts to date—15 cts. each).

21777. Cost of Electrical Energy. R. E. Crompton (El-Began April 27—3 parts to date—30 cts. each).

21993. Chloride of Lead Battery. E. Andreoli (E R L-Began May 4—2 parts to date—30 cts. each).

22059. Practical Notes on Dynamo-Calculation. Alfred E. Wiener (E W-Began May 19—4 parts to date—15 cts. each).

22361. Switzerland as the Present Electrical Center of Europe. Ill. Frederick Bathurst (E W-Began June 2—2 parts to date—15 cts. each)

22490. A Method for the Treatment of Rotating or Alternating Vectors With an Application to Alternate Current Motors. Ill. Galileo Ferraris (El-Began May 25—1 part to date—30 cts).

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22044. The Arnold System of Electric Power Station Construction (E R N Y-May 16.) 2000 w.

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*22209. Electricity in Saw-Mills and Workshops (M W-May 18.) 3000 w.

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*22253. Electricity as a Motive Power in the Iron and Steel Industries. D. Selby-Bigge (C G-May 18.) 5000 w.

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*22487. On a Synchronous Alternate-Current Electric Motor. Galileo Ferraris (El-May 25.) 900 w.

*22521. The Bazacle Electric Power Station at Toulouse. Ill. (I. & I-May 18.) 1600 w.

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22573. On the Design of Electro-Magnets for Specific Duty. P. Matthews (E W-June 9.) 1000 w.

22574. Electrical Shop Equipment. Ill. Howard L. Ingersoll (E W-June 9.) 1200.

Serials.

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*22213. The "Lancet" Commission Report on Gas-Fires. Charles W. Folkard (J G L-May 15.) 2800 w.

*22214. Discussion of H. Lees' paper—"Gas Undertakings in Relation to the Use of Gas Engines" (J G L-May 15.) 3500 w.

*22270 Gaseous Fuel with Special Reference to the Theory of Its Production. A. Humboldt Sexton (I C T-May 18.) 3000 w.

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*22275. Motors for Lighting, or Generator Gas v. Engines with Saturated or Superheated Steam. Bryan Donkin (G E M-May 10.) 2300 w.

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*22454. Enrichment of Coal Gas. J. Fergusson Bell (G W-May 26.) 4200 w.

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22466. Street Main Pressure. Irvin Butterworth, with Discussion (P A-June 1.) 4800 w.

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21887. Testing Gas Engines. J. A. (M W-Began May 4—Ended May 11—2 parts—30 cts. each).

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*22155. Breakdowns at Sea—Review of book by A. Ritchie Leask (Tr–May 11.) 1500 w.

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*22292. The Suez Canal Shipping (Tr–May 18.) 800 w.

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Serials

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22150. Economy of Operation of Elevator Installations. Editorial (E R-May 19) 900 w.

22174. The Specialization of the Machinist Trade. F. J. Masten (S M-May 15.) 1000 w.

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*22277. The Phonograph at Work (I C B-May 18.) 1400 w.

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†22341. Cost of Machine Tools per Pound. W. H. VanDervoort (Tech-1893-94.) 1200 w.

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*22470. Design and Repairs (Eng L-May 25.) 1600 w.

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19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M-Began Feb—4 parts to date—30 cts. each).

19802. Mechanical Refrigeration. Ill. R. C. Carpenter (S J E-Began Feb—4 parts to date—30 cts. each).

20900. Mechanical Drawing—Elementary Hints for Shopmen. Ill. (T-Began April 1—4 parts to date—15 cts. each).

21762. Emery and Other Abrasives. T. Dunkin Paret (J F I-Began May—Ended June—2 parts—45 cts. each).

21818. Systems of Piece Work (I S F-Began May—2 parts to date—30 cts. each).

21819. On the Transmission of Power. A. E. Chodzko (I S F-Began May—2 parts to date—30 cts. each).

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*21973. Methods of Preparing Polished Surfaces of Iron and Steel for Microscopic Examination. J. E. Stead (I C T-May 4) 5800 w.

*21974. Scandinavia as a Source of Iron Ore Supply. Jeremiah Head, with Discussion (I C T-May 4.) 10000 w.

*21975. The Analysis of Steel. (Abstract.) H. K. Bamber (I C T-May 4.) 1300 w.

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*21980. The Forest of Dean as a Producing Field for Bessemer Ores. Walter J. May (I S C-May 4.) 1100 w.

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22040. A Method of Ascertaining the Value of Iron Ore, Limestone and Coke in Blast Furnace Use. R. E. Chambers (Ir Age-May 17.) 1500 w.

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*22522. Estimation of Nickel in Nickel Steel (I & I-May 18.) 1500 w.

†22532. Benjamin Huntsman, of Sheffield, the Inventor of Crucible Steel. Ill. R. A. Hadfield (Tr A M E-June.) 3500 w.

†22533. Gold-Milling at the North Star Mine, Grass Valley, Nevada County, Cal. Ill. Emile Rector-Abradie (Tr A M E-June.) 2000 w.

†22535. The Heat-Treatment of Steel. Henry M. Howe (Tr A M E-June.) 20700 w.

†22538. The Allotropism of Gold. Henry Louis (Tr A M E-June.) 1600 w.

22561. The Amalgamated Scale for Iron and Steel Workers (Ir Age-June 7.) 1200 w.

22566. Foundry Use of Physical and Chemical Tests. W. J. Keep (A M-June 7.) 1300 w.

22614. The Cyanide Process. Walter H. Virgoe (E M J-June 9.) 2200 w.

Serials.

19145. Cupola Management. Edward Kirk. (Met W-Began Jan. 27—Ended May 19—12 parts—15 cts. each).

20737. British Ore Producing Districts to Compete with Spanish Minerals. Walter J. May (Inv-Began March 10—3 parts to date—30 cts. each).

21201. Lacquer and Bronze Work. William Norman Brown (Pl D-Began April—2 parts to date—30 cts. each).

21330. Steel and Its Manufacture. Henry Webb (I S C-Began April 6—2 parts to date—30 cts. each).

21558. Method of Capillary Electrolytic Sluice in the Extraction of Gold. J. H. Jory (M S P-Began April 21—2 parts to date—15 cts. each).

21715. Practical Blacksmithing. James F. Hobart (T-Began May 1—2 parts to date—15 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27—2 parts to date—30 cts. each).

22104. Variations in the Milling of Gold Ores—Grass Valley, California. Ill. T. A. Rickard (E M J-Began May 19—3 parts to date—15 cts. each).

MILITARY ENGINEERING.

21942. The Use of Water-Tube Boilers in the Navy. Walter M. MacFarland (Eng-May 12.) 3500 w.

21953. Effect of Small Bore Bullets.—The Wounds of the Mannlicher Magazine Rifle. A. M. Fernandez de Ybarra (A & N J-May 12.) 2800 w.

21994. Whalebacks Unfitted for War Vessels (M R C-May 10.) 800 w.

22014.—§1. Coast Artillery Fire Instruction (J U S A-April.) 59000 w.

22015.—§1. Coast Artillery Practice. J. B. Richardson (J U S A-April.) 9500 w.

22016.—§1. The Attack of a Coast Fortress. I. F. B. Elmslie. II. R. F. Johnson (J U S A-April.) 23500 w.

22065. The Newest Schichan Torpedo Boats—Built for the Brazilian Government. Ill. (Sc A S-May 19.) 500 w.

*22114. The Latest Concerning Dowe's Bullet-proof Coat (Inv-May 12.) 700 w.

*22123. Captain Jaques on American Armor. Editorial (Eng L-May 11.) 1300 w.

22225. The 150-Ton Portable Gun Scales of the Watervliet Arsenal. Ill. (Sc A-May 26.) 900 w.

*22229. Maximilian and Mexico. Ill. John Heard, Jr. (Sc M-June.) 14000 w.

*22230. The Future of the Wounded in War. Archibald Forbes (Sc M-June.) 7200 w.

*22247. The Crampton-Smith Position Finder. Ill. (E May 18.) 1500 w.

*22251. The French Ironclad "Jaureguiberry." Ill. (E-May 18) 1600 w.

22261. Test of the "Indiana's" Side Armor. Ill. (E M J-May 26.) 500 w.

22267. The Naval Armor Plate Scandal (Eng-May 26) 2000 w.

*22299. The Explosion at Waltham Abbey. Editorial (Eng L-May 18.) 1600 w.

22346.—$1.25. Contract Trial of the "Olympia." Ill. R. E. Carney (J A N E-May.) 4800 w.

22347.—$1.25. The Propulsive Power of Screw-Ships. James N. Warrington (J A N E-May.) 3000 w.

22372. Notes on the History of the Breech-Loading Gun. Ill. (Sc A-June 2.) 1800 w.

22373. The Air Ship Division of the German Army. Ill. (Sc A S-June 2.) 700 w.

22381. The Home of Joan of Arc. Ill. W. D. McCrackan (Cos-June.) 1800 w.

†22385. Military Drill in the Schools. Benjamin F. Trueblood (C M-June.) 1000 w.

22390. Harveyized Armor (A & N J-June 2.) 1000 w.

*22472. The Failure of Thick Harveyed Nickel Plates. Editorial (Eng L-May 25.) 1000 w.

22519. A Great Mare's Nest Exposed—The Carnegie Plates. (From the Philadelphia Record) (B I S-June 6.) 700 w.

†22549. Armor Protection for Heavy Guns in Battleships. Ill. William C. Foley (J F I-June.) 2700 w.

22562. Auxiliary Coast Defense (Ir Age-June 7.) 450 w.

Serials.

21989. Krupp Ordnance. Ill. (E-Began May 4—3 parts to date—30 cts. each).

21991. The New Spanish Belted Cruisers. Ill. (E-Began May 4—2 parts to date—30 cts. each).

22523. The Qualities and Performances of Recent First-Class Battleships. W. H. White (I & I-Began May 18—2 parts to date—30 cts. each).

MINING.

*21899. Quarrying Methods of the Ancients. Ill. W. F. Durfee (E Mag-July.) 3000 w.

21934. Coal Fields of Roaring Creek.—Along the West Virginia Central and Pittsburg. Thomas Bruce (M R-May 11) 1500 w.

21950. An Ancient Indian Quarry. O. T. Mason (I Age-May.) 600 w.

21957. Variations in Bilbao Iron Ore. (Extracts.) Cyriaque Helson (E M J-May 12.) 400 w.

21958. Mining Industry of British Columbia, 1893. S. S. Fowler (E M J-May 12.) 1400 w.

*21995. Working Mines Adjacent to and Under Canals (C G-May 4.) 4500 w.

*21996. Working by Inclined Tranches at the Blanzy Colliery. Ill. Léon Mathet (C G-May 4.) 800 w.

*21998. Some Belgian Combustible Rocks Assimilated or Assimilable to Cannel Coal. Adolphe Firket (C G-May 4.) 900 w.

†22034. The Mines (Eight Hours) Bill. D. A. Thomas (F R-May.) 3000 w.

†22036. The Profits of Coal Pits. G. P. Bidder (N C-May.) 2600 w.

*22047. Gold Mining an Industry. Robert D. Dixon (A M S-March 24.) 1500 w.

*22049. The Mineral Wealth of Victoria. James Stirling (A M S-March 31.) 3000 w.

*22051. The Central Australian Mineral Fields (A M S-April 7.) 1800 w.

*22053. The Etheridge Goldfield (A M S-April 14.) 2400 w.

22063. The Cryolite of Greenland. Francis H. Knauff (Sc A-May 19.) 950 w.

22075. Coal Fields Around Astor.—In the Circle of the Great Pittsburg Seam. Thomas Bruce (M R-May 18.) 1200 w.

22080. Lively Times at Angel's Camp. Eugene B. Cushing (M S P-May 12.) 2000 w.

22125. California Gold Boom (Min R-May 10.) 1200 w.

*22126. Working Mines Adjacent to and under Railways (C G-May 11.) 4200 w.

*22128. Deep Boring on the Canadian System, near Freidstadt, Austria. R. Nelson Boyd, with Discussion (C G-May 11.) 6500 w.

22152. A Compressed-Air Pumping Plant. Ill. (E R-May 19.) 1800 w.

22176. The Geological Age of Gold Deposits. Arthur Lakes (M I T-May 17.) 1800 w.

22243. More about Southern Gold Ores. J. J. Newman (M R-May 25.) 1800 w.

*22254. The Mechanical Ventilation of Collieries.—Discussion at Meeting of Manchester Geological Society (C G-May 18.) 2300 w.

*22255. The Pembrokeshire Coalfield. Ill. John George Summons (C G-May 18.) 1200 w.

22260. The Mineral Production of the United States in 1892 and 1893. (E M J-May 26.) 1000 w.

*22313. Coal Mining in New Zealand (Min W-May 19.) 1000 w.

22316. Points on Coal Exportation (B D-May 26.) 900 w.

22317. The Displacement of Miners' Labor (B D-May 26.) 1000 w.

†22333. A Peruvian Salt Mine. Robert Peele, Jr. (S M Q-April.) 1300 w.

22393. Story of a Texas Mine.—Supposed to Have Been Worked by the Spaniards Many Years Ago (M R-June 1.) 600 w.

22431. The Petroleum Fields of India. R. D. Oldham (O P D R-June 4.) 7500 w.

22435. The Phosphate Situation (C M R-Feb.) 1500 w.

22436. Screening and Cleaning Coal. Henry T. Wales (C M R-Feb.) 4500 w.

22437. Some Remarks on the Gold Production of Nova Scotia and How It May Be Increased. B. C. Wilson, with Discussion (C M R-March.) 2300 w.

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22439. Mechanical Appliances for the Shipment of Coal. S. W. Allen (C M R-March.) 7000 w.

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22443. Notes on Blasting in Coal Mines. H. Bigg-Wither (C M R-April.) 2800 w.

22444. Mica Deposts of the Ottawa District. Tr. R. W. Ells (C M R-April.) 2000 w.

*22452. The Miners' International Conference (I C T-May 25.) 1000 w.

22468. Coosa Coal Field, Alabama. William Brewer (T-June 1.) 1300 w.

†22480. Notes on the Gold Ores of California. H. W. Turner (A J S-June.) 2600 w.

22493. Coal Trade Prospects (B D-June 2.) 900 w.

†22534. The Silver Mines of Lake Valley, New Mexico. Ill. Ellis Clark (Tr R A M E-June.) 7600 w.

†22536. Iron Ores of East Texas. W. Kennedy (Tr A M E-June.) 9000 w.

†22541. Correlations in the Coal Rocks West of Pocahontas, Flat Top, Virginia. C. R. Boyd (Tr A M E-June.) 1200 w.

†22543. The Zinc-Ore Deposits of Southwestern New Mexico. Ill. William P. Blake (Tr A M E-June.) 2800 w.

†22544. Coal-Sections Developed by Recent Operations in Wise County, Virginia. Ill. Franklin Bache (Tr A M E-June.) 1000 w.

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*22618. The Ventilation of Mines.—Explanation of the Apparent Superiority of Recent Fans over the Guibal. Ill. Gustave Hanarte (C E-June.) 3000 w.

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Serials.

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20407. Mine Surveying.—Methods Employed in the Coal Fields of Pennsylvania. Ill. Otto C. Burkhart (C E-Began March—4 parts to date—30 cts. each).

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21956. The Goldfields of Western Australia. Albert F. Calvert (E M J-Began May 12—2 parts to date—15 cts. each).

22045. The Wyalong Goldfield (A M S-Began March 24—4 parts to date—30 cts. each).

22055. Commercial Mining. F. Danvers Power (A M S-Began April 14—1 part to date—30 cts).

22127. The Rhenish-Westphalian Coalfield. M. E. Tomson (C G-Began May 11—3 parts to date—30 cts. each).

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22586. The Mineral Hydrocarbons.—Their History, Geography, Geology, Physical and Chemical Properties and Uses. Henry G. Hanks (M S P-Began June 2—1 part to date—15 cts).

22616. Metal Mining and Colliery Work Compared and Contrasted. Albert Williams, Jr. (C E-Began June—1 part to date—30 cts).

22617. A Typical Gold Mine.—Description of the Standley Consolidated Mine, Colorado. Ill. Arthur Lakes (C E-Began June—1 part to date—30 cts).

RAILROADING.

*21901. Development of the Electric Locomotive. Ill. B. J. Arnold (E Mag-July.) 3000 w.

*21902. The Political and Economic Importance of the Great Siberian Railway. Hermann Schonfeld (E Mag-July.) 3000 w.

21926. Amendments to the Interchange Rules (E N-May 10.) 1200 w.

21945. The Bellefontaine Shops of C. C. C. & St. L. Railway. Ill. (R G-May 11.) 900 w.

21946. Modifications of Van Borries' System of Compounding. Ill. (R G-May 11.) 450 w.

21947. English Railroad Companies as Street Carriers. C. H. G. (R G-May 11.) 1900 w.

*21999. Railway Bridge over the Lau-Ho, China. Ill. (Eng L-May 4.) 1800 w.

22017. Discussion of G. P. Conn's paper—"Transportation of Persons having Infectious or Contagious Diseases" (R A-May 11.) 2800 w.

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22077. The Rise of the Railroad Club. Editorial (E M–May 17.) 1600 w.

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*22110. The Webb System of Compounding Locomotives (E–May 11.) 2500 w.

22117. Important Railroad Decision—The Right of Quitting Business (I I G–May.) 800 w.

*22168. Compound Locomotives in Switzerland (A J R A–May.) 700 w.

*22181. The New Northwest Passage to the Orient. J. Macdonald Oxley (L Mag–June.) 2000 w.

*22228. A New System of Block Signals. Arthur A. Skeels (J A E S–March.) 1800 w.

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*22293. The North British Railway Company's Locomotives, Past and Present. Ill. A. E. Lockyer (R W–May.) 4000 w.

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*22296. The French Railway System (R W–May.) 2000 w.

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22309. From What Class of Employés Should Locomotive Firemen Be Selected? W. G. Wattson (R A–May 25.) 2000 w.

†22337. Turntable Frogs. Ill. Milo S. Ketchum (Tech–1893-94.) 900 w.

†22338. The Readjustment of Long Railroad Tangents. William D. Pence (Tech–1893-94.) 2300 w.

†22339. Methods of Handling Freight. A. M. Munn (Tech–1893-94.) 1200 w.

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22356. The Legalization of Traffic Compacts. Commissioner Knapp, and Editorial (R R–May 19.) 4500 w.

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*22406. Traditions of the Camden and Amboy Railroad.—From Philadelphia Public Ledger (N C B–June.) 1700 w.

*22424. A Trip in Old Mexico. Ill. J. A. H. (L E–June.) 5000 w.

*22425. Reforming the Counterbalance Practice of a Big Road. Ill. (L E–June.) 1500 w.

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*22528. Confiscation of the Works and Plant of the Piræus-Larissa Railway.—Statement of Messrs. Eckersley, Godfrey and Liddelow, Contractors (I & I–May 25.) 2000 w.

22577. The Coal Hoisting and Distributing Plant of the Manhattan Elevated Railroad, of New York City. Ill. (Sc A–June 9.) 1300 w.

22587. Mount Lowe Railway. Ill. (M S P–June 2.) 600 w.

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22602. Interior Decoration of Passenger Cars. Ill. (R G–June 8.) 3600 w.

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22637. Improved Car Service by Reason of Improvements in Car Construction. E. W. Grieves (R C J–June.) 1700 w.

22638. Steel Car Frames. G. R. Joughins (R C J–June.) 1400 w.

22640. The Cleaning of Passenger Cars. A. M. Waitt (R C J-June.) 3000 w.

22641. Wear and Tear and Failure Under Fair Usage. George S. Hodgins (R C J-June.) 2500 w.

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22644. Proposed Improvement in Passenger Car Construction.—With Special Reference to the Abolition of Platforms and Vestibules. Ill. Ernest Merrick (R C J-June.) 1500 w.

Serials.

9689. Railroad Car Design. Ill. Arthur Richards (R C J-Began Jan.—4 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan.—5 parts to date—15 cts. each).

21679. The Reciprocating Parts of a Locomotive. Ill. F. J. Cole (A E R J-Began May—2 parts to date—30 cts. each).

21689. Locomotive Boiler Tests. Ill. James F. Hobart (N C B-Began May—2 parts to date—30 cts. each).

22354. Bills of Lading.—Reply to Viator's Second Article (R R-Began May 19—Ended May 26—2 parts—15 cts each).

22399. Present Practice in Specified Loadings for Railroad Bridges. Ward Baldwin (R G-Began June 1—2 parts to date—15 cts. each).

22639. A Master Car Builder's Reminiscences.—A Review of Some Improvements of the Last Half Century. John Kirby (R C J-Began June—1 part to date—15 cts).

STREET RAILWAYS.

21911. A Plea for Inanimate Power and Steel Roads. Martin Dodge (G R-May.) 2800 w.

21923. T-Rails and Spiral Curves on the Denver Street Railways. Ill. (E N-May 10.) 600 w.

*22008. Electric Welding at St. Louis.—Three and One-Half Miles of Continuous Rails. Ill. (S R R-May 15.) 1600 w.

*22009. High vs Low Speed Engines.—Reply to C. P. Young. M. A. Green (S R R-May 15.) 2500 w.

*22011. The New Power Houses of the Chicago Street Railroad Company. Ill. (S R R-May 15.) 1800 w.

*22012. The Bristol, England, Tramways. Ill. (S R R-May 15.) 800 w.

*22013. The Sandusky, Milan and Norwalk Electric Railway. Ill. (S R R-May 15.) 1800 w.

*22020. Electric Traction in Railway Tunnels. Frank B. Lea (E E L-May 4.) 1300 w.

22062. The Lawrence Underground Conduit Electric Trolley Railroad. Ill. (Sc A-May 19.) 1300 w.

*22132. The Connelly Motor v. Electricity for Driving Tramcars. Sydney F. Walker (E R L-May 11.) 1100 w.

22153. Frank H. Mason, on Gas Motors for Street Railways in Germany (A G L J-May 21.) 2500 w.

†22182. Tests of a Small Electric Railway Plant. Jesse M. Smith (A S M E-June.) 1500 w.

22234. A City Tax on Street Railway Earnings. J. C. Ransom (R G-May 25.) 1000 w.

22238. The Brott Electric Elevated Bicycle Railway Company. Ill. (E A-May 26.) 1300 w.

22242. Rapid Transit Prospects in New York, Boston and Philadelphia (E N-May 24.) 800 w.

22288. The Barrows Elevated Electric Railway. Ill. (M & B-April.) 1600 w.

*22300. Tests of Reckenzaun Tramway Motors and Gearing. Ill. Philip Dawson (E R L-May 18.) 1500 w.

22330. Barmen Electric Rack Railway. Ill. (S R G-May 26.) 1400 w.

22365. Power Brakes for Electric Motor Cars. Ill. Edward C. Boynton (E W-June 2.) 1200 w.

22400. The Metropolitan Railroads of New York and London. Editorial (R G-June 1.) 1500 w.

22416. The Trolley Appreciated in Brooklyn.—From New York Tribune (W E-June 2.) 1400 w.

†22491. The Cincinnati, Newport and Covington Railway. Ill. (S R J-June.) 6500 w.

*22501. Electric Traction. Editorial (P Eng-May 25.) 2800 w.

22514. Test of the Neversink Mountain Electric Road. Ill. Hermann S. Hering and William S. Aldrich (E W-June 5.) 21800 w.

22629. An Automatic Car Fender.—Invention of Elbridge J. Smith. Ill. (I Age-June.) 1800 w.

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18225. Experiences of a Superintendent. C. P. Young (S R R-Began Dec.—5 parts to date—30 cts. each).

18549. The Intrinsic Value of Street Railway Investments. Edward E. Higgins (S R J—Began Jan.—6 parts to date—45 cts. each).

18711. Electric Railway Motors: Their Construction and Operation. Nelson W. Perry (S R G-Began Jan. 6—21 parts to date—15 cts. each).

21260. Electric Traction. C. H. Wilkinson (E P-Began April—2 parts to date—30 cts each).

21747. Steam Tramway Locomotives. Ill. (R W-Began April—2 parts to date—30 cts. each).

22085. The Metropolitan Railroads of New York and London (R G-Began May 18—3 parts to date—15 cts. each).

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21920. The Anderson System of Garbage Cremation. Ill. (E N-May 10.) 1500 w.

†22037. Sunshine and Microbes. Percy Frankland (N C-May.) 2800 w.

*22264. Modern Disinfecting Apparatus. Ill. William H. Ford (A H-June.) 2600 w.

22304.—75 cts. The Electrical Purification of Water. Thomas M. Drown (J N E W–June.) 3300 w.

*22526. Chemical Processes for the Treatment of Sewage (I & I–May 25.) 1500 w.

*22554. Sewers for Small Cities. M. Tschirgi, Jr. (P–June.) 1200 w.

Serials.

14839. Water Purification in America. Ill. (E N–Began Aug. 3—11 parts to date—15 cts. each).

19132. The Metropolitan Sewerage Systems of Massachusetts. Ill. (E N–Began Jan. 25—5 parts to date—15 cts. each).

19813. American Plumbing (D E–Began Feb. —4 parts to date—30 cts. each).

20194. Sewage Disposal. George E. Waring, Jr. (E R–Began March 3—4 parts to date—15 cts. each).

22506. Sanitary Plumbing (N B–Began June —1 part to date—30 cts).

STEAM ENGINEERING.

21943. Economy of Independent Auxiliary Pumps. Otto H. Mueller. (Eng–May 12.) 2200 w.

21949 An Economical Engine.—The Highest Duty Yet Reported in Mill Work. (B J C–May 12.) 600 w.

*21981. The Utilization of Anthracite Slack. (I S C–May 4.) 1600 w.

22102. Moisture in Steam.—Tests of Babcock and Wilcox Boilers at Cambridge Power Station of the West End Street Railway, Boston. (B J C–May 19.) 1500 w.

22103. Electricity for Engineers —Locating and Overcoming Some Troubles. (B J C–May 19.) 1000 w.

*22113. The Grafton High Speed Engine. Edward W. Anderson (E–May 11.) 6000 w.

†22185. Notes on the Theory of Shaft Governors. Ill. Albert K. Mansfield (A S M E–June.) 3600 w.

†22186. The Theory of the Steam-Jacket; Current Practice. R. H. Thurston (A S M E–June.) 30000 w.

†22187. Mechanical Draft. Ill. William R. Roney (A S M E–June.) 2200 w.

†22188. Heat Units and Specifications for Pumping Engines. Albert F. Hall (A S M E–June.) 3000 w.

†22190. Results of Measurements of the Water Consumption of an Unjacketed 1600 Horse-Power Compound Harris-Corliss Engine. J. E. Denton, D. S. Jacobus and R. H. Rice (A S M E–June.) 1200 w.

†22191. The Saturation Curve as a Reference Line for Indicator Diagrams. R. C. Carpenter (A S M E–June.) 2000 w.

†22192. Corrosion of Steam Drums. Ill. James McBride (A S M E–June.) 2000 w.

†22193. Effect of Varying the Weight of Regenerator in a Hot-Air Engine. G. W. Bissell (A S M E–June.) 350 w.

†22194. Cylinder Proportions for Compound Engines Determined by Their Free Expansion Losses. Frank H. Ball (A S M E–June.) 3600 w.

†22195. First Stationary Steam Engine in America. F. R. Hutton (A S M E–June.) 1800 w.

†22198. Cost of an Indicated Horse Power. De Lourcy May (A S M E–June.) 1500 w.

†22199. A New Method of Compound Steam Distribution. F. M. Rites (A S M E–June.) 2000 w.

†22201. Results of Experiments with a Fifty Horse-Power Single Non-Condensing Ball and Wood Engine to Determine the Influence of Compression on the Water Consumption. D. S. Jacobus (A S M E–June.) 1000 w.

22204. Triple Expansion Steam Engines, Built by the Pupils of the Cincinnati Technical School. Ill. (A M–May 24.) 700 w.

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*22328. An Analytical Study of the Initial Condensation in Steam Engines. Lionel S. Marks (S J E–May.) 3000 w.

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22350.—$1.25. Practical Application of Formulæ for Finding the Turning Effort on the Crank Shaft of an Engine. B. C. Bryan (J A N E–May.) 3000 w.

22368. High and Low-water Alarms.—An Explanation. W. H. Wakeman (A M–May 31.) 1200 w.

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22266. Air Pumps and Condensers. E. A. Blackwell (Eng-Began May 26—2 parts to date—15 cts. each).

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AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J P....Am. Jour. of Politics. *m.* $3. New York.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S M E.Am. Soc. of Mec. Eng. *m.* New York.
B U W..Bul. of the Univ. of Wis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B D.....The Black Diamond. *w.* $3. Chicago.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S ...Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C ...Boston Jour. of Commerce. *w.* $3. Boston.
B & W..Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York
C M R..Canadian Mining Rec. *m.* $1.50. Ottawa.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $2. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $1. Chicago.
Elek ....Elektron. *m.* $3. Boston.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng.....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.

F.....Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F...Garden and Forest. *w.* $4. New York.
G R.....Good Roads. *m.* $1. New York.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
I W .. ..Indus. World. *w.* $3. Chicago
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J N E W.Jour. N. E. Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
Met W...Metal Worker. *w.* $2. N. Y.
M,G.....Manufacturer's Gazette. *w.* $3. Boston.
Mill.....Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Ml N....The Monumental News. *m.* $1. Chicago.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N E M..New Eng. Magazine. *m.* $3. Boston,
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N. Y.
P..... ..Paving. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P E C P.Procd. Engineer's Club. *q.* $2. Phila.
Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G ....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R R.....Railway Review. *w.* $2. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
S... .....Stone. *m.* $2. Chicago.
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San.....Sanitarian. *m.* $4. Brooklyn.
Sc.....Science. *w.* $3.50. New York.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Cal.
Sea.....Seaboard. *w.* $2. New York.
S Ec.....Social Economist. *m.* $2. New York.
S In.....Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....ScientificMachinist. *s-m.* $1.50. Cleveland, O.
So L.....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q....School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W E.....Western Electrician. *w.* $3. Chicago.

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A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 20*s.* Sydney.
B..... The Builder. *w.* 26*s.* London.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
B M. ....Banker's Mag. *m.* 18*s.* London,
B T J....Board of Trade Journal. *m.* 6*s.* London.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
E.....Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E G.....Engineers' Gazette. *m.* 8*s.* London.
E L.....Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P.....Electrical Plant. *m.* 6*s.* London.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L....Electrical Review. *w.* 21*s.* 8*d.* London.
F R.....Fortnightly Review. *m.* $4.50. London.
F'y.....Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G M.....The Geol. Mag. *m.* 18*s.* London.
G W.....Gas World. *w.* 13*s.* London.
I & I....Industries and Iron. *w.* £1. London.
I & S....Iron & Steel Trades' Jour. *w.* 25*s.* Lond.
I C B... .Carpenter and Builder. *w.* 8*s.* 8*d.* London.
ICT.... ..Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
I Eng....Indian Engineer. *w.* 20 Rs. Calcutta.
Irm.. ...The Ironmonger. *w.* 10*s.* London.
Inv ..Invention. *w.* 11*s.* London.
I S C.....The Iron, Steel and Coal Times. *w.* £1 6*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
M.....Machinery. *m.* 9*s.* London.
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M W....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N C.....Nineteenth Century. *m.* $4.50. London.
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S L.....Steamship. *m* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
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19078. Problems in Stone-Cutting. Ill. E. W. Hind (S-Began Jan.—5 parts to date—30 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. (B B-Began Jan.—6 parts to date—30 cts. each).

19749. Lead Light and Stained Glass Glazing. Jehan Le Vitrier (Pl D-Began Feb.—5 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D-Began March—4 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (A A-Began April 14—3 parts to date—15 cts. each).

21464. Henry Van Brunt—Architect, Writer and Philosopher. P. B. Wight (I A—Began April—3 parts to date—45 cts. each).

21618. Bay Windows and Oriels. Ill. F. Jerman (I C B-Began April 20—4 parts to date—30 cts. each).

21638. Style. Léon Labrouste (A A-Began April 28—6 parts to date—15 cts. each).

21639. The Italian Renaissance. A. D. F. Hamlin (A A-Began April 28—5 parts to date 15 cts. each).

21736. The Art of Building Among the Romans. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April—3 parts to date—30 cts. each).

21940. The Architectural Models in the Metropolitan Museum. G. W. E. Field (S A-Began May—3 parts to date—30 cts. each).

22286. "The Design of Naked Flooring." R. W. W. (I E-Began April 28—3 parts to date—45 cts. each).

22648. Theater-Building for American Cities. Ill. Dankmar Adler (E Mag-Began Aug—1 part to date—15 cts).

22700. Architectural Essays — Review of Work by Henry Van Brunt (A L—Began June 1—2 parts to date—30 cts. each).

22702. The Practical Side of Traveling. Arthur Bolton (A L-Began June 1—Ended June 8—2 parts—30 cts. each).

22717. Terra Cotta in Skeleton Construction. Ill. D. Everett Waid (B B-Began May—1 part to date—30 cts).

22773. Semicircular Headed Sashes and Frames. Ill. (B & W-Began June—1 part to date—15 cts).

23044. French Styles of Architecture. Ill. E. Rivoalen (A A-Began June 23—3 parts to date—15 cts. each).

23045. The Essential Conditions of Safety in Theatres. William Paul Gerhard (A A-Began June 23—2 parts to date—15 cts. each).

23079. Dunblane Cathedral. R. Rowand Anderson (I C B-Began June 15—2 parts to date—30 cts. each).

23164. Hospital Planning. H. George Sanders (C A-Began June—1 part to date—30 cts).

CIVIL ENGINEERING.

*22668. The Reclamation of the Zuyder Zee. Ill. (Eng L-June 1.) 2000 w.

22785. The Hudson River Bridge of the New York and New Jersey Bridge Company. Ill. (Sc A-June 16.) 1500 w.

†22801. The Proposed Channel Bridge. Albert, Prince de Monaco (F R-June.) 2500 w.

22806. Revising the Constitution of the American Society of Civil Engineers (E N-June 14.) 3000 w.

22809. Tequixquiac Tunnel, Valley of Mexico (Abstract.) Albert Johnstone Campbell and Frederick William Abbot (E N-June 14.) 900 w.

*22857. Brick Paving. J. D. Wardle (S R R-June 15.) 900 w.

†22926. Kistna Bridge, Cement Consumption. F. J. E. Spring (I E-May 19.) 1500 w.

*22941. Through "Bugsby's Hole" (I C B-June 8.) 2000 w.

†22949. The Great Blue Stone Industry. Ill. Henry Balch Ingram (P S M-July.) 2000 w.

22990. Tests of Asphalt Paving Materials at Philadelphia, with Criticism (E N-June 21.) 5400 w.

23005.—$1.50. The Development and Recent Improvement of Concrete-Iron Highway Bridges. Ill. Fr. von Emperger, with Discussion (T C E-April.) 20000 w.

23021. Asphaltum in the United States (E R-June 23.) 1600 w.

*23078. Boston Brick Paving (I C B-June 15.) 900 w.

23131. The Nicaragua Canal (M R-June 29.) 500 w.

23175. Projects for Ship Canals in America (E N-June 28.) 1500 w.

23176. The Philadelphia Asphalt Tests.—Letters from Lewis M. Haupt and Frederick H. Lewis (E N-June 28.) 1100 w.

23179. The Results of the Budapest Bridge Competition. (Abstract.) Ill. W. G. Triest (E N-June 28.) 1000 w.

*23212. Brick for Street Pavements. M. D. Burke (B A-June 22.) 3300 w.

*23244. Asphalte and Its Uses (I C B-June 22.) 2000 w.

23271. The Cape Hatteras Light-House. Ill. (E R-June 30.) 2800 w.

23331. Good Road Movement in California. H. H. Markham (G R-July.) 1600 w.

23332. The Drainage of Roads. W. H. Breithaupt (G R-July.) 900 w.

23333. What Street Improvements Have Done for Cincinnati. Michael G. Heintz (G R-July.) 1200 w.

*23334. The Various Cements and How to Use Them. M. M. Defrees (P-July.) 2000 w.

*23335. The Physical Properties of Asphalt.—Another Reply to Capt. Torrey by Prof. De Smedt (P-July.) 1400 w.

We supply copies of these articles. See introductory.

*23336. The Foundation for Brick Pavements. J. D. Wardle (P-July.) 1000 w.

†23344. Dover Harbor Works. Ill. (I E-June 2.) 1300 w.

23356. Removal of Rock in 35 feet of Water, North River. John A. Bensel (E N-July 5.) 3000 w.

*23417. The Tower Bridge. Ill. (E-June 29.) 800 w.

*23448 Building the Tay Bridge. Ill. (I C B-June 29.) 1600 w.

Serials.

19649. Beams of Uniform Strength. William White Robertson (I E-Began Jan. 6—8 parts to date—45 cts. each).

21592. The Harlem River Speedway. Ill. (E R-Began April 28—3 parts to date—15 cts. each).

22473. Piles and Pile Driving. J. R. Baterden (Eng L-Began May 25—Ended June 1—2 parts—30 cts. each).

22793. Road Engineering. W. H. Breithaupt (C Eng-Began June—1 part to date—15 cts).

23080. Cement Testing. Spencer B. Newberry (I C B-Began June 15—3 parts to date—30 cts. each).

ELECTRIC LIGHTING.

*22649. Beginnings and Future of the Arc Lamp. Ill. S. M. Hamill (E Mag-Aug.) 3500 w.

*22683. The Brighton Electric Supply Station. Ill. (El-June 1.) 2800 w.

*22849. Country House Electric Lighting. Sidney á Court (E E L-June 8.) 2500 w.

22908. Chimneys of the New Edison Lighting Station, New York City. Ill. (E R-June 16.) 1700 w.

*22934. Electricity Supply Stations.—Portsmouth Corporation Works. Ill. (E R L-June 8.) 7000 w.

22963. The New Central Station of the Elmira, N. Y., Illuminating Co. Ill. (E E N Y-June 20.) 1400 w.

22976. Electric Lighting Effects at Keith's Theatre, Boston. Ill. (E N Y-June 20.) 1300 w.

*23060. Incandescence Lamps —Experiments on Their Variations in Consumption and Luminous Power (E R L-June 15.) 800 w.

*23101. Street Lighting by Alternating Arcs. Charles G. Armstrong (S R E N-June.) 1400 w.

23329. Incandescent Lamps. C. W. Naylor (Pr-July.) 3200 w.

23359. A Central Station on the Pacific Slope. Ill. (E W-July 7.) 1800 w.

23360. The Inductance and Capacity of Suspended Wires. E. J. Houston and A. E. Kennelly (E W-July 7.) 1200 w.

*23426. Electric Lighting from Primary Batteries (I & I-June 29.) 1900 w.

*23440. Synchronizing Clocks for Electric Meters. Ill. J. W. Jones (El-June 29.) 800 w.

*23445. The Bradford Corporation Electric Supply, with the Results of Four Years' Working. James N. Schoolbred (E E L-June 29.) 2500 w.

Serials.

22131. The Incandescence Lamp. A. Bainville (E R L-Began May 11—3 parts to date—30 cts. each).

ELECTRIC MISCELLANY.

*22646. Electricity Direct from Coal. William Ostwald. (E Mag-Aug.) 3000 w.

22755. An Electric Quartette (A S-June 9.) 1000 w.

22796. Estimate of the Distance to Which Niagara Water Power Can Be Economically Transmitted by Electricity. I. A Reply to Messrs. Houston and Kennelly. II. Edwin J. Houston and A. E. Kennelly (E E N Y-June 13.) 1200 w.

22810. Concerning Overhead Wires. (Abstract.) C. H. Morse (E A-June 16.) 850 w.

*22868. The Work of Hertz (E-June 8.) 1000 w.

22889. Electrical Smelting (A S-June 16.) 900 w.

†22950. Sketch of Heinrich Hertz. Hèlene Bonfort (P S M-July.) 4000 w.

22981. Magnetic Formulæ. Reginald A. Fessenden (E W-June 23.) 700 w.

22983. Some Storage Battery Phenomena. W. W. Griscom (E W-June 23.) 2500 w.

*23035. Notes on Electrolysis. John Waddell (El-June 15.) 4500 w.

*23040. Two Important Meetings of German Electrical Engineers at Leipsic (E E L-June 15.) 3000 w.

*23059. Non-Polar Dynamos in America. Editorial (E R L-June 15.) 1200 w.

*23061. The Waterhouse Electricity Meter. Ill. (E R L-June 15.) 1400 w.

23097.—75 cts. On an Apparatus for the Measurement of Coefficients of Self-Induction and the Investigation of the Phenomena of Alternating Currents. Frank A. Laws (T Q-Dec.) 2300 w.

23113. A Reliable Method of Recording Variable Current Curves. Ill. A. C. Crehore (E N Y-June 27.) 4000 w.

23114. Reactance. Ill. Charles Proteus Steinmetz and Frederick Bedell (E N Y-June 27.) 1000 w.

23141. Electrical Resonance as Related to the Transmission of Energy. William A. Anthony, with Editorial (E E N Y-June 27.) 5200 w.

23142. The Factory and Apparatus of the Fort Wayne Electric Corporation. Ill. (E E N Y-June 27.) 5500 w.

*23226. Experiments on Brown's Alternating Current Motor. Riccardo Arno (E R L-June 22.) 600 w.

*23228. Cooking by Electricity (E R L-June 22.) 2200 w.

We supply copies of these articles. See introductory.

*23232. Electrolytic Electricity Meters (I & I–June 22.) 2500 w.

*23236. On the Finding of Faults in Coils Wound on Conducting Bobbins. Albert Campbell (El–June 22.) 600 w.

*23237. A New Phenomenon Observed in the Passage of Electricity Through Badly Conducting Liquids. Ill. O. Lehmann (El–June 22.) 1900 w.

*23238. Electricity in the Kitchen (El–June 22.) 1600 w.

*23442. Modern Electro-Chemical Theory and its Bearing upon the Practice of the Future. Dr. Ostwald, with Editorial (El–June 29.) 4500 w.

*23455. Electrical Distribution by Alternating Currents. Editorial (E R L–June 29.) 1300 w.

*23457. Rear-Admiral Fleuriais's Electric Log. Ill. (E R L–June 29.) 900 w.

Serials.

21396. Coming Developments in Electricity. George D. Shepardson (E A–Began April 21—4 parts to date—15 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Weiner (E W–Began May 19—8 parts to date—15 cts. each).

22361. Switzerland as the Present Electrical Centre of Europe. Ill. Frederick Bathurst (E W–Began June 2—Ended June 30—5 parts—15 cts. each).

22490. A Method for the Treatment of Rotating or Alternating Vectors, with an Application to Alternate Current Motors. Galileo Ferraris (El–Began May 25—Ended June 15—4 parts—30 cts. each).

22947. The Work of Hertz. Oliver Lodge (N–Began June 7—2 parts to date—30 cts. each).

23439. On Impulsive Current—Rushes in Inductive Circuits. Alfred Hay (El–Began June 29—1 part to date—30 cts).

ELECTRIC POWER.

22774. The New Stanley-Kelley-Chesney Alternating Current Generator. Ill. (E N Y–June 13.) 3800 w.

22794. Systems of Transmitting Electric Power. Gisbert Kapp (C Eng–June.) 900 w.

22795. Versatility of the Electric Motor (C Eng–June.) 700 w.

*22895. The Behavior of Single-Phase-Synchronous Motors. C. E. Hewitt and James Lyman (S J E–June.) 1500 w.

23023. Distribution of Electrical Power. W. H. Adams (E M J–June 23.) 2000 w.

†23026. Some Practical Hints in Dynamo Design. Gilbert Wilkes (B U W–No. 2.) 6500 w.

23089. Electrical Power Transmission at West Pullman, Ill. Ill. (W E–June 23.) 1600 w.

23121. The Adoption of Electric Power in Steel Works. Clifford C. Smith (Ir Age–June 28.) 2500 w.

†23152. A Twelve-Mile Transmission of Power by Electricity. Ill. Thomas H. Leggett (Tr A M E–July.) 7500 w.

23303. Power Transmission at the Paris Exposition of 1900. Editorial (E E N Y–July 4.) 1000 w.

23337. Experiments on Two-Phase Motors. Ill. Dr. Louis Duncan, S. H. Brown, W. P. Anderson and S. Q. Hayes (E R N Y–July 4.) 2600 w.

†23342. The Electric Long Distance Transmission Plant at Portland, Ore. Ill. (S R J–July.) 3800 w.

*23459. Central Stations for Electric Energy in Germany (E R L–June 29.) 1200 w.

Serials.

22570. On the Measurement of the Power of Polyphased Currents. Alexander D. Lunt (E W–Began June 9—3 parts to date—15 cts. each).

GAS ENGINEERING.

22786. Artificial Fuel Gas. Henry Wurtz (Sc A S–June 16.) 4300 w.

22840. Purification of Gas. Edward C. Jones, with Discussion (P A–June 15.) 4000 w.

22841. Small Things Around a Small Works. M. C. Osborn, with Discussion (P A–June 15.) 1600 w.

22842. How We Do at Our House. T. R. Parker, with Discussion (P A–June 15.) 2400 w.

22843. The Relations of Lighting Companies to the Public. C. W. Quilty (P A–June 15.) 1200 w.

22844. Proper Books of Record. John A. Britton, with Discussion (P A–June 15.) 6300 w.

22845. Foes to Our Gas Mains and Service Pipes. John Kempf, Jr., with Discussion (P A–June 15.) 2400 w.

*22873. Report on Trials of a Crossley Gas Engine at Messrs. Wallaert Frêres' Mill, Lille. Aime Witz (Eng L–June 8.) 1200 w.

*22930. Notes on the Enrichment of Coal Gas, More Particularly Bearing Upon Enrichment by the Peebles Oil-Gas Process. Ill. S. Glover (J G L–June 5.) 4200 w.

*22931. The Introduction, Development and Practical Working of Oxy-Oil Gas Process at the Huddersfield Gas-Works. Ill. W. R. Herring (J G L–June 5.) 4600 w.

*22932. Discussion on the Papers of Messrs. Bell, Glover and Herring (J G L–June 5.) 4000 w.

*22969. Relation of Carburetted Water Gas to the European Gas Industry in 1894. A. M. Paddon (J G L–June 12.) 3000 w.

*23047. Mechanical Appliances at the Manchester Corporation Gas Works. Ill. (I & I–June 15.) 3800 w.

*23058. Residuals and Their Value. James Ferrier (G E M–June 11.) 1000 w.

23066. Motors for Lighting, or Generator Gas vs. Engines with Saturated or Superheated Steam. Bryan Donkin (A G L J–June 25.) 6000 w.

*23068. The Crisis in the Gas Supply. Editorial (Eng L-June 15.) 900 w.

23163. Apparatus for Analyzing Gases. Ill. Patent of E. A. Uehling (E M J-June 30.) 1000 w.

*23166. Inaugural Address of John West (J G L-June 19.) 7800 w.

*23167. Street Lighting with Incandescent Gas Burners (J G L-June 19.) 3000 w.

*23168. The Profit Sharing System. George Livesey (J G L-June 19.) 1400 w.

23172. Some Electric Plants in Chicago Driven by Gas Engines. Ill. (W E-June 30.) 900 w.

*23229. Gas Engine Power for Private and Public Electric Supply. Ed. C. de Segundo (E R L-June 22.) 3500 w.

23256. Mr. A. Crova's Address before the Association of French Gas Engineers (A G L J-July 2.) 6000 w.

*23346. Illuminating Power and Illuminating Effect. Thomas Newbigging (J G L-June 26.) 3800 w.

*23347. A Plea for Differential Charges for Gas. George Anderson (J G L-June 26.) 1500 w.

*23348. An Improvement in the Construction of Atmospheric Burners. C. B. Voisey (J G L-June 26.) 2500 w.

*23349. A First Season's Experience of Carburetted Water Gas. J. Stelfox (J G L-June 26.) 5600 w.

*23350. The Profit-Sharing System—Letter from George Livesey (J G L-June 26.) 1000 w.

*23450. Steam Applied as an Aid to the Revivification of Oxide of Iron in Situ. Ill. Frederick G. Dexter (G W-June 30.) 3800 w.

Serials.

13881. Labor Saving Appliances in Gas Works (I & I-Began June 16, 1893—Ended June 8, 1894—3 parts—30 cts. each).

20417. Gas Stoves and Ventilation. Edward J. Smith (Pl D-Began March—Ended June—4 parts—30 cts. each).

21052. The Development of the Gasholder. Alex. Mc I. Clelland (J G L-Began March 27—Ended June 12—5 parts—30 cts each).

21760. On Gas Burners, Gas Pressure Regulators and Governor Burners, Gas Globes and Globe Holders, and Gas Fixtures. William Paul Gerhard (J F I-Began May—Ended July—3 parts—45 cts. each).

22714. Recent Developments in Gas Manufacture (I & I-Began June 1—1 part to date—30 cts).

23209. Recent Improvements in the Utilization of Gas (G W-Began June 23—1 part to date—30 cts).

23282. The Gas and Electricity Supply of Blackpool. William Chew (E E L-Began June 22—Ended June 29—2 parts—30 cts. each).

23473. Distribution of Gas. J. P. Gill (A G L J-Began July 9—1 part to date—15 cts).

HYDRAULICS.

22756. Arid America's Opportunity (A S-June 9.) 1100 w.

†22778. The Proposed Nile Reservoir. I. The Devastation of Nubia. J. P. Mahaffy. II. The Submergence of Philæ. Frank Dillon (N C-June.) 5600 w.

22792. Acadian Dikes. Ill. (C Eng-June.) 1800 w.

22805. Reconstruction of the Water-Works of Alliance, O. Ill. L. L. Tribus (E N-June 14.) 2800 w.

*22826. Notes on Water Power Equipment. A. W. Hunking, with Discussion (J A E S-April.) 8000 w.

22847. Damming the Nile—Philæ. John Fowler (B C-June 16.) 2000 w.

22911. The Old Pumps and Wells of New York. (From the Evening Post.) (A & B-June 16.) 1600 w.

*23093. The Nile Reservoir. Editorial (E-June 15.) 1800 w.

*23094. Power Transmission at Periyar (E-June 15.) 1600 w.

23104. The Water Power Revival (A S-June 23.) 600 w.

†23149. Artesian Well Prospects in Eastern Virginia, Maryland and Delaware. N. H. Darton (Tr A M E-July.) 6800 w.

23280. Laying a Sixteen-Inch Main Across a Rocky Mill Stream and over a Dam. George F. Chace (F W-June 30.) 1350 w.

23283. Irrigation in California. Ill. S. P. Adams (M & B-May.) 1500 w.

23312. The Irrigation of Lawns. Ill. (Sc A-July 7.) 350 w.

23353. Submerged Water Works Intake, Whiting, Ind. C. McLennan (E N-July 5.) 500 w.

23389. Notes on an Insecure Reservoir Bottom. Louis L. Tribus (E R-July 7.) 1000 w.

Serials.

18676. The Pumping Engine; Its Many Points, Faults and Peculiarities. Ernest W Naylor (F W-Began Jan. 6—16 parts to date—15 cts. each).

21433. Glasgow Water Works. Ill. (E-Began April 13—6 parts to date—30 cts. each).

22559. Irrigation by Pumping. Ill. Alfred Chatterton (I E-Began May 5—3 parts to date—45 cts. each).

22670. The Regulation of the Iron Gate and Other Cataracts on the Lower Danube. Ill. Bela von Gonda (Eng L-Began June 1—2 parts to date—30 cts. each).

23253. Water Pressure Engines. S. H. Hollands (P Eng-Began June 22—Ended June 29—2 parts—30 cts. each).

23279. What a Water Supply Engineer Can Do in the Fire Department. James E. Tryon (F W-Began June 30—2 parts to date—15 cts. each).

23375. The Problem of Future Water Supplies for New York, Philadelphia, Brooklyn and

Jersey City. Peter Milne (F W–Began July 7—1 part to date—15 cts).

INDUSTRIAL CHEMISTRY.

†22777. Modern Explosives. Wentworth Lascelles Scott (N C–June.) 5000 w.

*22919. The Industrial Electrolysis of Fused Salts. Ill. Bertram Blount (E P–June.) 2200 w.

†23108. Some Sources of Error in Our Methods of Determining Potash in Fertilizers and German Potash Salts. N. Robinson (J A E S–June.) 2800 w.

†23110. On the Estimation of Sulphur in Pyrites. Thomas S. Gladding (J A E S–June.) 2000 w.

†23111. Electrolytic Separations. Edgar F. Smith and Henry E. Spencer (J A E S–June.) 1400 w.

†23411. On the Analysis of American Refined Copper. Harry F. Keller (J F I–July.) 1200 w.

Serials.

15176. The Chemical and Physical Examination of Portland Cement. Thomas B. Stillman (J A E S–Began April, 1893—Ended June, 1894—4 parts—45 cts. each).

INDUSTRIAL SOCIOLOGY.

*22647. The Prevailing Jealousy of Wealth. William Nelson Black (E Mag–Aug.) 3000 w.

*22678. Compensation for Losses by Riots (I & I–April 27.) 1200 w.

22681. The Padrone Nuisance. Edward E. Hale (B C–June 9.) 1200 w.

22713. Rate Wars and Strikes.—A Study. William S. Huntington (R A–June 8.) 900 w.

22719. Why Was There a Strike? (B D–June 9.) 1000 w.

22720. Day-Dreams of Utopia (B D–June 9.) 1000 w.

22746.—75 cts. The Homestead Strike. Edward W. Bemis (J P E–June.) 9500 w.

22749.—75 cts. The Army of the Commonweal. T. B. Veblen (J P E–June.) 1500 w.

†22799. The New Factory Bill: As It Affects Women. Evelyn March-Phillipps (F R–June. 5400 w.

22887. Industry and Competition (B D–June 16.) 900 w.

22888. Incipient Revolution (B D–June 16.) 900 w.

†22948. The Meaning of Corporations and Trusts. Logan G. McPherson (P S M–July.) 11000 w.

22956.—$1. The Future Problem of Charity and the Unemployed. J. G. Brooks (An A A–July.) 10000 w.

22957.—$1. Peaceable Boycotting. Chester A. Reed (An A A–July.) 7200 w.

22958.—$1. Rent and Profit. C. W. Macfarlane (An A A–July.) 5000 w.

22960. Miners' Unions. Editorial (M I T–June 14.) 1100 w.

22965. Garrett on Capital and Labor (Ir Age–June 21.) 1700 w.

*22970. Eight Hours for Work.—Comments on book by John Rae (J G L–June 12.) 2500 w.

23038. Is It Law or Chaos? (B D–June 23.) 900 w.

*23042. Coxeyism and Its Commonwealers (R of R–June 15.) 9500 w.

*23092. The Royal Commission on Labor. Editorial (E–June 15.) 2100 w.

23102. The Latest "Trust." A. B. Salom (I I G–June.) 1200 w.

23115. The Cripple Creek Strike. Editorial (Min R–June 14.) 1000 w.

*23159. The Downfall of Coxeyism. Shirley Plumer Austin (Ch–July.) 3200 w.

*23208. Strikes and Lockouts in 1892 (C G–June 22.) 1200 w.

*23218. "Coxeyism": A Character Sketch. Ill. W. T. Stead (R of R–July.) 6000 w.

*23219. A Talk with Samuel Gompers, the Labor Leader (R of R–July.) 2400 w.

*23220. Strikes and Lock-Outs. Editorial (Eng L–June 22.) 1600 w.

*23255. The History of Trades' Unionism.—Review of book by Sidney and Beatrice Webb (B–June 23.) 2000 w.

23278. Industrial Turmoils (B D–June 30.) 900 w.

†23381. The Crusade of the Unemployed. Henry Frank (A–July.) 2300 w.

23394. The Panacea—Relating to Strikes, etc. Frederick E. Goodrich (B C–July 7.) 1000 w.

*23415. Final Report of the Royal Commission on Labor. Editorial (E–June 29.) 2200 w.

*23420. Recommendations of the Royal Commission on Labor (C G–June 29.) 7200 w.

LANDSCAPE ENGINEERING.

22770. Water Courses in their Relation to the Public (G & F–June 13.) 1200 w.

22771. American Parks—Druid Hill, Baltimore. M. C. Robbins (G & F–June 13.) 1100 w.

23112. "Nature and the Rich" (G & F–June 27.) 1500 w.

23302. Art and Nature (G & F–July 4.) 1400 w.

†23382. Public Parks and Playgrounds: A Symposium. Compiled by Thomas E. Will (A–July.) 6000 w.

MARINE ENGINEERING.

*22661. The Suez Canal and Shipping (E–June 1.) 1350 w.

*22669. The Proposed Birmingham Ship Canal. Ill. (Eng L–June 1.) 8200 w.

*22709. The New German and Austrian Shipping Combination (Tr–June 1.) 1200 w.

22798. Free Admission to American Registry of Ships Built in Foreign Countries.—Views of the Minority (Sea–June 14.) 3300 w.

*22831. British Shipowners and the British Flag.—A Movement at Cardiff to Register Abroad (F'y–June 8.) 1600 w.

*22866. The Glasgow and South-Western

Railway Company's Clyde Steamers (E–June 8.) 1800 w.

*22867. The Manchester Ship Canal. Editorial (E–June 8.) 3800 w.

22906. Test Borings, Outer Diamond Shoals. Ill. (E R–June 16.) 2000 w.

*22912. Ocean Mail Competition (R P L–June 1.) 1900 w.

*22913. Royal Opening of the Ship Canal (R P L–June 1.) 3500 w.

*22929. International Congress on Inland Navigation (Tr–June 8.) 1800 w.

†22954. Apprentice Life at Sea. John G. Rowe (W R–June.) 1600 w.

22977. Skillful Engineering.—A Lighthouse off Hatteras (Sea–June 21.) 1100 w.

22989. Water-Jet Propulsion on the River Elbe, Germany—with Editorial. Ill. (E N–June 21.) 4500 w.

*23031. Manchester Ship Canal.—Threatened Disaster.—Speech of Sir John Harwood (F'y–June 15.) 2900 w.

23037. American Ships and American Coal (B D–June 23.) 700 w.

*23081. A Coracle, or Hide-Boat. Ill. (I C B–June 15.) 1500 w.

*23082. Clinker and Canoe. Ill. (I C B–June 15.) 1000 w.

*23086. The Ships of Ancient Greece (Tr–June 15.) 2500 w.

23127. The French Aluminum Yacht Vendenesse (Sc A–June 30.) 1000 w.

23133. Queen of Steam-boats.—The Priscilla. Ill. (Sea–June 28.) 3000 w.

23134. The Leading Ship-building Plants of the Atlantic Coast, with Editorial. Ill. (Sea–June 28.) 6400 w.

†23147. Superstitions of the Sea. Ill. J. D. Jerrold Kelley (C M–July.) 4800 w.

*23201. The Situation at Hull (Tr–June 22.) 1300 w.

23214. Antarctica, or the Hypothetical Southern Continent. Ill. A. W. Greely (Cos–July.) 3200 w.

*23225. Marine Dangers (E–June 22.) 1400 w.

23272. The Use of Compressed Air in Raising Vessels.—Raising the "Plymouth" (E R–June 30.) 900 w.

23287.—50 cts. Steamship Northwest. Ill. (M R C–June 30.) 13000 w.

23330. Sault Ste. Marie, Mich. Ill. George A. Cady (G R–July.) 1200 w.

†23413. Shortening the Time for Correct Sounding. F. M. F. Cazin (J F I–July.) 2000 w.

*23418. Liverpool and the Ship Canal. Editorial (E–June 29.) 2000 w.

*23430. The Proposed Canadian Line of Mail Steamers (Tr–June 29.) 1000 w.

23472. A House Boat.—Owned by Pierre Lorillard (From the N. Y. Sun.) (Eng–July 7.) 700 w.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6—11 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. L. V. E. (I E–Began April 14—6 parts to date—45 cts. each).

MECHANICAL ENGINEERING.

*22653. The Early Lives of Great Inventors. Leicester Allen (E Mag–Aug.) 2500 w.

22682. Lubricating Oils. A. C. J. Charlier (O P D R–June 11.) 1800 w.

*22686. Joints for Pipes (I C B–June 1.) 1500 w.

*22703. Chains v. Ropes for Lifting Machinery. Ill. Editorial (P Eng–June 1.) 1600 w.

22791. Presidential Address of Eckley B. Coxe (A M–June 14.) 6200 w.

22804. Turning and Lifting Machinery for 450 feet Swing Span, Alton Bridge. Ill. J. H. Warden (E N–June 14.) 1800 w.

†22828. A Simple Water Resistance Prony Brake. F. M. Leavitt (S In–April.) 800 w.

†22830. The Pneumatic Pyrometer. Ill. Edward E. Uehling (S In–April.) 3000 w.

*22851. Samuel Crompton: Inventor. M. E. Bradshaw-Isherwood (Inv–June 9.) 3000 w.

*22896. Experiments to Determine the Power Absorbed by Shafting, when Transmitting Varying Loads. Lionel S. Marks and S. Henry Barraclough (S J E–June.) 600 w.

22973. A Pattern System. Walter B. Snow (A M–June 21.) 2400 w.

23003.—$1 50. Cableways. Ill. Spencer Miller (T C E–April.) 4500 w.

23018. About Binders and Fastening Pulleys (B J C–June 23.) 1000 w.

23098.—75 cts. A New Torsion Machine. Ill. Edward F. Miller (T Q–Dec.) 1500 w.

23099.—75 cts. The Efficiency of Jack-Screws. Ill. Edward F. Miller and William A. Johnston (T Q–Dec.) 900 w.

23119. An Intricate Wire Forming Machine—Designed by Robert C. Manville. Ill. (Ir Age–June 28.) 1500 w.

23129. What Has Economy to Do with Compressed Air? Frank Richards (A M–June 28.) 900 w.

23186. A Mechanical Fluid—Novel Method of Taking Up Wear of Bearing. Ill. (B J C–June 30.) 800 w.

*23210. The Oil Engine Trials (Irm–June 23.) 2700 w.

*23231. Chains and Wire Ropes for Cranes (I & I–June 22.) 1400 w.

*23239. On the Whirling and Vibration of Shafts. Stanley Dunkerley (El–June 22.) 2000 w.

*23250. Crane Chain Accidents. Editorial (P Eng–June 22.) 1600 w.

†23290. Spiral Goniometry in Its Relation to the Measurement of Activity. Ill. Carl Barus (A J S–July.) 3000 w.

23326. Style and Finish in Mechanical Work (A M–July 5.) 1300 w.

23327. Plates of Uniform Strength. Albert E. Guy (A M–July 5.) 1200 w.

23328. Testing Indicator Springs. Edward J. Willis (A M–July 5.) 1700 w.

†23345. Lubricating Oils (I E–June 2.) 1200 w.

23351. The Pneumatic Tube System of the City Press Association of Chicago, Ill. W. L. Stebbings (E N–July 5.) 2000 w.

†23407. The Manufacture of Very Accurate Straight Edges. Ill. F. L. O. Wadsworth (J F I–July.) 6500 w.

23478. Report on Special Shop Tools (R A–July 6.) 5000 w.

Serials.

17362. Arithmetic of the Screw and of Symmetrical Rings. Ill. Leicester Allen (A M–Began Nov. 16—4 parts to date—15 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M–Began Dec. 7—10 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El–Began Dec. 1—16 parts to date—30 cts. each).

20900. Mechanical Drawing. Ill. (T–Began April 1—5 parts to date—15 cts. each).

22414. Oil and Petroleum Engines. H. M. Waynforth (M W–Began May 25—Ended June 22—4 parts—30 cts. each).

METALLURGY.

*22652. Electric Welding and Metal-Working. Ill. Herman Lemp (E Mag–Aug.) 3000 w.

*22698. Pewter. Ill. J. Starkie Gardner, with Discussion (J S A–June 1.) 18000 w.

*22727. The Smithfield Iron Works, Leeds. Ill. (R W–June.) 2700 w.

*22769. Some Improvements in Treating Minerals for the Wet Extraction of Gold and Silver. John Storer (A M S–May 12.) 1600 w.

22797. The Strength and Resilience of Structural Cast Iron. J. B. Johnson (Ir Age–June 14.) 3000 w.

22835. The Iron Works of Samaca, Colombia. Thomas B. Nichols (E M J–June 2.) 1600 w.

*22880. Staffordshire as a Steel Producing District (C G–June 8.) 1500 w.

*22883. Unemployed Iron Making Plant (I C T–June 8.) 1000 w.

*22884. The Regulation of Ironworkers' Wages (I C T–June 8.) 1300 w.

*22945. Consolidating Steel Ingots. J. L. Sebenius. (From Cassier's Magazine) (P Eng–June 8.) 1400 w.

22961. The Cyanide Mill in the Black Hills (M I T–June 14.) 1000 w.

22967. Steel Manufacture in the South. J. B. Nau (Ir Age–June 21.) 3600 w.

22974. Cupola Practice. Herbert M. Ramp (A M–June 21.) 1600 w.

23004.—$1.50. An Instructive Eye-Bar Test. A. C. Cunningham, with Discussion (T C E–April.) 8300 w.

23015. Sentinella's Sodium Flux for Iron Founders. Walter J. May (A M & I W–June 22.) 500 w.

23016 On the Determination of Loss in Iron Ore Concentration. Walter J. May (A M & I W–June 22.) 700 w.

*23050. The Metric System Applied to the Iron and Steel Trades. Walter J. May (P Eng–June 15.) 1000 w.

23120. Progress in Galvanizing. Ill. (Ir Age–June 28.) 1700 w.

23124. Electric Smelting, Germany. Frank H. Mason (E W–June 30.) 1500 w.

†23150. The Manufacture of Open-Hearth Steel in Sweden. Ill. Erik Gison Odelstjerna (Tr A M E–July.) 6700 w.

23181. Coke Making in the South. (Extract.) Richard Thomas (A M & I W–June 29.) 1700 w.

23182. Jigging Ores. Walter J. May (A M & I W–June 29.) 700 w.

*23202. Rolling Rods Directly from Small Ingots (C G–June 22.) 1800 w.

*23205. The Eight-Hour Day at Cleveland Blast Furnaces (C G–June 22.) 1400 w.

*23235. German Competition in the Iron and Steel Industries.—Report of Special Committee to the Board of Management (I C T–June 22.) 4000 w.

23305. Do Iron and Steel Crystallize in Service? Paul Kreuzpointner (Ir Age–July 5.) 4000 w.

23384. The Microscopic Metallurgy of Copper Alloys. Ill. M. Guillemin (E M J–July 7.) 1300 w.

23385. Dressing Zinc and Lead Ores in Southwest Missouri and Southeast Kansas. George T. Cooley (E M J–July 7.) 1200 w.

*23400. Improvements in Rolling Mill Plant. Ill. (Eng L–June 29.) 500 w.

*23428. Lead Smelting in the Ore Hearth in Scotland. Ill. A. H. Sexton (I & I–June 29.) 1200 w.

23436. The Iron Works of Samaca, Colombia (Min R–June 21.) 2000 w.

23461. Vast Rolling Mills in China (I W–July 5.) 600 w.

Serials.

21201. Lacquer and Bronze Work. William Norman Brown (Pl D–Began April—3 parts to date—30 cts. each).

21369. Press Work of Sheet Metals. Ill. Oberlin Smith (Ir Age–Began April 19—2 parts to date—15 cts. each).

21715. Practical Blacksmithing. James F. Hobart (T–Began May 1—3 parts to date—15 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng–Began April 27—4 parts to date—30 cts. each).

22710. Science for Ironmongers (Irm–Began June 2—3 parts to date—30 cts. each).

22790. Foundry Inventiveness. Ill. S. Bolland (Am–Began June 14—2 parts to date—15 cts. each).

22854. The Dry Assay of Ores (I & I–Began June 8—4 parts to date—30 cts. each).

23162. Iron-Making at Birmingham, Ala. Edmund C. Pechin (E M J–Began June 30—2 parts to date—15 cts. each).

MILITARY ENGINEERING.

*22651. The Modern Battle-Ship as a Fighting Machine. George W. Melville (E Mag–Aug.) 3000 w.

*22671. Warships and Critics. Editorial (Eng L–June 1.) 1900 w.

*22680. The Destructive Effects of Small Projectiles (N–May 31.) 1700 w.

*22697. Dowe's Bullet-Proof Cuirass in London (Inv–June 2.) 3500 w.

*22852. The Maxim-um "Joke" and a Minimum of Satisfaction; or, Bullet-"Spoof" and Other Cuirasses, Involving Curses and Cupidity (Inv–June 9.) 4300 w.

*22871. The United States Armor-Plate Scandal. Editorial (Eng L–June 8.) 1300 w.

*23001. The Gettysburg Week. Philip Schaff (Sc M–July.) 6000 w.

23012. Character of the Armor Manufactured at the Carnegie Steel Works, as Demonstrated by Recent Trials. Ill. (A & N J–June 23.) 6000 w.

*23085. The Latest Phases of the Bullet Proof Epidemic and Disclosures Referring to Certain Patents (Inv–June 16.) 4500 w.

†23107. How to Make West Point More Useful. F. A. Mitchel (N A R–July.) 2100 w.

23126. Recent Trials of Rapid Firing Six Pounder Machine Guns. Ill. (Sc A–June 30.) 600 w.

23128. Bombs and Infernal Machines. Ill. Lieut. Col. Hennebert, in La Nature (Sc A S–June 30.) 3800 w.

†23144. The Evolution of a Battleship. Ill. Albert Franklin Matthews (C M–July.) 6500 w.

†23145. "The Star Spangled Banner." John C. Carpenter (C M–July.) 3000 w.

23153.—75 cts. American Military Roads and Bridges. P. S. Michie (J M S I–July.) 3500 w.

23154.—75 cts. The Nicaragua Canal in Its Military Aspects. William K. Hamilton (J M S I–July.) 4000 w.

23155.—75 cts. Portable Intrenching Tools for Infantry. Ill. W. C. Wren (J M S I–July) 5200 w.

*23161. The Restoration of Joan of Arc. M. Munier-Jolain (Ch–July.) 1800 w.

23213. Some Rare Napoleonic Medals. Ill. J. Howe Adams (Cos–July.) 3000 w.

23215. Louis Kossuth. Ill. Madam Adam (Cos–July.) 3300 w.

23274. Our Nation's Defenses. William P. Craighill (E R–June 30.) 6000 w.

23310. The Stability of War Ships (Sc A–July 7.) 1000 w.

23311. The Lengthening of the Gunboats Machias and Castine. Ill. (Sc A–July 7.) 900 w.

*23366. Transportation of a Torpedo Boat from Toulon to Cherbourg. Ill. M. Partiot (A E R J–July.) 4000 w.

*23398. The Fastest Ship in the World—the "Daring." (Eng L–June 29.) 1500 w.

*23416. The New Thornycroft Torpedo Vessel. Editorial (E–June 29.) 3000 w.

23462. Torpedo Boat "Ericsson." Ill. (I Age–July) 800 w.

23480. Errant Ingenuity and Devious Devices.—Tricks that Defy Inspectors.—Armor Plates. B. F. Spalding (A S–July 7.) 3000 w.

Serials.

20214. A General Review of Existing Artillery. Gaston Moch (J M S I–Began March —3 parts to date—75 cts. each).

21582. The New Regulations for Field Fortifications in the German Army. Ill. Thomas C. Patterson (J M S I–Began May—2 parts to date—75 cts. each).

21991. The New Spanish Belted Cruisers. Ill. (E–Began May 4—4 parts to date—30 cts. each).

MINING.

*22645. Colorado's New Gold Camps. Ill. Arthur Lakes (E Mag–Aug.) 3500 w.

†22666. Peculiarities of the Mystic Coal Seam. H. Foster Bain (A G–June.) 1200 w.

†22667. The Origin of Anthracite. Charles Rollin Keyes (A G–June.) 1200 w.

22699. The Elk Garden and Upper Potomac Coal Fields of West Virginia. Joseph D. Weeks (A M & P W–June 8.) 2700 w.

*22735. Russian Coalfields and Their Production (C G–June 1.) 3800 w.

*22736. The Southeastern Coalfield (C G–June 1.) 800 w.

*22737. The Historical Hottenguer Shaft of the Epinac Colliery. M. Nongarède (C G–June 1.) 3200 w.

*22738. California Coal. J. Coventry I'Anson (C G–June.) 1500 w.

*22753. The Lake Superior Sandstones. Letter from H. G. Rothwell (S–June.) 1200 w.

*22761. Three Interviews—Opinions About Coolgardie (A M S–April 28.) 3800 w.

*22765. The Coolgardie Goldfield (A M S–May 5.) 3500 w.

22787. Deep Boring near Freidstadt, Austria. R. Nelson Boyd (Sc A S–June 16.) 6800 w.

22812. Mines and Mills of Northern California. Carrol G. Sprague (M S P–June 9.) 2000 w.

22821. Zinc Ore Deposits of New Mexico. (Abstract.) William P. Blake (O P D R–June 18.) 1700 w.

22834. The Amy and Silversmith Decision Again. R. W. Raymond (E M J–June 16.) 1200 w.

*22862. British Coal for the United States (C T J–June 9.) 1000 w.

*22875. Economical Development of the Rhenish-Westphalian Coalfield. (Extract.) Dr. Reismann-Grone and E. Schrödter (C G–June 8.) 4200 w.

*22876. Income Tax on Mines and Quarries (C G–June 8.) 8500 w.

*22877. The Working of Thick Coal Seams by Longwall. M. E. (C G–June 8.) 800 w.

*22878. The Pacific Coast Coalfields (C G–June 8.) 1100 w.

*22879. Steel v. Timber for Supporting the Roof of Mines. (Extract.) C. C. Ellison (C G–June 8.) 1400 w.

*22881. Main Doors as Factors in the Ventilation of Coal Mines Under the Effects of an Explosion of Gases. Ill. (C G–June 8.) 900 w.

*22882. Kolar Goldfields (Min W–June 9.) 1700 w.

†22951. The Miner's Eight-Hour Question. Walter Trevelyan Thomson (W R–June.) 3200 w.

22962. Geology of the Cripple Creek Gold Mining District, Colorado. Whitman Cross (M I T–June 14.) 4800 w.

22985. Folsom's Former Gold Yield. (E. C. R. in the Sacramento Bee) (M S P–June 16.) 1200 w.

22991. Florida Phosphate Industry (M R–June 22.) 1300 w.

23039. Coal in the South (B D–June 23.) 950 w.

*23051. The Shropshire Coalfields (C G–June 15.) 2500 w.

*23052. On the Proportion of Carbon Dioxide (Chokedamp) in Air Which Is Extinctive to Flame. Frank Clowes (C G–June 15.) 1500 w.

*23053. The Mineral Development of Nova Scotia. (Abstract.) E. Gilpin (C G–June 15.) 1600 w.

*23054. The Probable Range of the Coal Measures in Southern England. W. Boyd-Dawkins (C G–June 15.) 3200 w.

*23055. Salt Deposits in the Isle of Man. (Abstract.) W. Boyd Dawkins (C G–June 15.) 1000 w.

*23056. Electrical Transmission of Power with Diphase Currents for Mining Purposes (C G–June 15.) 800 w.

*23057. The Salt Mines of Carrick-Fergus. Alexander Miscampbell (C G–June 15.) 1300 w.

*23087. The Rating of Mines. E. J. Castle (I C T–June 15.) 4000 w.

23116. Alaska Gold Mines (Min R–June 14.) 1700 w.

23132. Phosphate Rock.—An Official Report by the United States Geological Survey (M R–June 29.) 1600 w.

23143. The Commercial Aspect of Coal Mining. (Extract.) G. A. Mitchell (C M R–June.) 2000 w.

†23148. Mine Explosions Generated by Grahamite Dust.—Discussion of paper by William Glenn (Tr A M E–July.) 3300 w.

†23151. The Elk Garden and Upper Potomac Coal-Fields of West Virginia. J. D. Weeks (Tr A M E–July.) 2800 w.

23185. Facts About Metals.—Quicksilver and How It Is Mined, etc. (B J C–June 30.) 1800 w.

*23188. The Goldfields of British Guiana (B T J–June.) 1200 w.

*23191. The Deadlock in the Coal Trade Controversy (C T J–June 23.) 1400 w.

*23204. Compressed Air for Transmission of Power in Coal Mines. M. E. (C G–June 22.) 800 w.

*23206. The Shropshire Coalfields and Their Surroundings. John Randall (C G–June 22.) 1000 w.

23277. New Markets for Coal (B D–June 30.) 900 w.

23286. Gold in Quartzite and Porphyry. A. F. Wuensch (M I T–June 28.) 1600 w.

23289. Negro Miners. Editorial (T–July 1.) 550 w.

23306. The Status of the Coal Miners' Strike in Alabama (Ir Age–July 5.) 1200 w.

23313. Underground Life and Labor in the Anthracite Region. (From the N. Y. Tribune.) (Sc A S–July 7.) 3500 w.

*23318. The Manchester Ship Canal.—Its Effect on Transportation and the Possibility of Putting Pennsylvania Anthracite Into England. W. H. Booth (C E–July.) 1500 w.

*23319. Pumping with Compressed Air.—The Nottingham Colliery, Plymouth, Penna. Ill. (C E–July.) 2200 w.

23364. Gold-Mining in Carolina. D. Allen Willey (M R–July 6.) 900 w.

*23419. Sosnowice Collieries, Dombrova Coalfield, Russian Poland. Ill. (C G–June 29.) 5500 w.

*23421. The Transmission of Power by Compressed Air for Above-Ground Purposes. M. E. (C G–June 29.) 1200 w.

*23422. Sliding Scales (C G–June 29.) 4200 w.

*23423. The Colliery Fireman: His Training, Treatment, Position and Duties. George Elce (I C T–June 29.) 4000 w.

23437. A Brief Sketch of Barnato's Rise. (From the Chicago Times.) (Min R–June 21.) 1200 w.

23438. To Save Coal Waste. (From the Carbondale, Pa., Leader.) (Min R–June 21.) 800 w.

Serials.

12450. The Coal Fields of Canada. Ill. William Hamilton Merritt (C E–Began May, 1893—13 parts to date—30 cts. each).

19079. Talks on Quarrying. Edward H. Williams, Jr. (S–Began Jan.—5 parts to date—30 cts. each).

20407. Mine Surveying.—Methods Employed in the Coal Fields of Pennsylvania. Otto C. Burkhart (C E–Began March—Ended July—5 parts—30 cts. each).

We supply copies of these articles. See introductory.

20413. Mining Methods. Ill. (C E-Began March—5 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—5 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—5 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—5 parts to date—30 cts. each).

20737. British Ore Producing Districts to Compete with Spanish Minerals. Walter J. May (Inv-Began March 10—4 parts to date—30 cts. each).

22045. The Wyalong Goldfield (A M S-Began March 24—7 parts to date—30 cts. each).

22053. The Ethridge Goldfield (A M S-Began April 14—2 parts to date—30 cts. each).

22055. Commercial Mining. F. Danvers Power (A M S-Began April 14—3 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons. Henry G. Hanks (M S P-Began June 2—4 parts to date—15 cts. each).

22616. Metal Mining. Albert Williams, Jr. (C E-Began June—2 parts to date—30 cts. each).

22617. A Typical Gold Mine.—Description of the Standley Consolidated Mine, Colorado. Ill. Arthur Lakes (C E-Began June—2 parts to date—30 cts. each).

22836. The Gold Mining Industry in Canada in 1893. Archibald Blue (E M J-Began June 16—2 parts to date—15 cts. each).

23207. The Origin and the Mode of the Formation of Coal. Adolphe Firket (C G-Began June 22—1 part to date—30 cts).

RAILROADING.

*22659. Early American Locomotives and Cars. Ill. (E-June.) 1500 w.

*22675. The Antofagasta (Chile) and Bolivia Railway (I & I-April 20.) 600 w.

*22679. The Upper Egypt Railway Extension. Ill. (I & I-May 4.) 800 w.

22711. Length of Steel Rails, with Editorial (R A-June 8.) 3000 w.

22712. The Miners' War Upon the Railways (R A-June 8.) 1200 w.

*22728. The Mersey Railway Engines. Ill. Clement E. Stretton (R W-June.) 700 w.

*22729. The Barmen Electric Rack Railway. Ill. (R W-June.) 1800 w.

*22731. Light Railways in Belgium. Ill. Frank B. Lea (R W-June.) 1800 w.

22748.—75 cts. The Pacific Railway Debts. Henry K. White (J P E-June.) 9500 w.

22757. Silver Memorial Vase of Department of Transportation Exhibits, World's Columbian Exposition. Ill. (R R-June 9.) 1200 w.

22759. The Reported Amendment to the Interstate Commerce Law, with Editorial (R R-June 9.) 5700 w.

22760. Couplers and Draft Appliances (R R-June 9.) 1700 w.

22802. The Stephenson Link Motion. J. Esrey Johnson, Jr. (E N-June 14.) 3300 w.

22808. Efficiency of Safety Plugs for Locomotive Boilers. Ill. (E N-June 14.) 1400 w.

22815. Concerning Locomotive Boiler Construction. James L. Spiers (R G-June 15.) 1200 w.

22816. Steel Freight Car Truck Frames, with Editorial. Ill. (R G-June 15.) 5600 w.

22817. Economy of Locomotives Compared with Stationary and Marine Engines (R G-June 15.) 1000 w.

22818. A Drawbar for Elevated Railroad Service. Ill. Design of D. L. Barnes (R G-June 15.) 700 w.

22819. Internal Friction of Locomotives (R G-June 15.) 2300 w.

*22822. French Railway Problems (R'y T-June 9.) 750 w.

22899 Are Fast Freight Lines an Evil? Editorial and Letters (R A-June 15.) 2200 w.

22900. The Railways and Coal Mine Strikers (R A-June 15.) 700 w.

22901. The Year's Progress in Car Construction. Ill. (R A-June 15.) 1600 w.

22902. M. C. B. Association Report on Steel Tired Wheels. Ill. (R A-June 15.) 250 w.

*22914. Rack Railways (R P L-June 1.) 1200 w.

*22915. Great Train Robberies (R P L-June 1.) 2100 w.

*22916. The Liverpool and Manchester Railway Sixty-five Years Ago.—Letter from George Stephenson, Oct. 25, 1829. (R P L-June 1.) 1300 w.

†22920. The Nilgiri Railway. Ill. (I E-May 12.) 1200 w.

*22928. The Uganda Railway (Tr-June 8.) 2100 w.

22988. Impact Tests of M. C. B. Couplers (E N-June 21.) 1300 w.

22998. Track Circuit Connection for Lock-and-Block Signaling. Ill. (R G-June 22.) 1200 w.

22999. Irregular Wear of Locomotive Driving Wheels. Ill. (R G-June 22.) 2000 w.

†23025. Track. L. F. Loree (B U W—No. 1.) 9500 w.

23073. Car Mileage and Accounts. Editorial. (R R-June 23.) 1000 w.

23074. The Requirements of Railroad Management (R R-June 23.) 800 w.

23084. The Heilmann Electric Locomotive.—Translation of an Article in L'Independant Remois (Eng-June 23.) 1200 w.

*23088. Light Railways for Agriculture (I C T-June 15.) 1100 w.

*23091. The London and South-Western Railway and Its Services (E-June 15.) 1800 w.

23103. High Freight Rates (A S-June 23.) 1300 w.

23105. Report on Wheel and Flange Gauges. Ill. (R A-June 22.) 5000 w.

23135. The St. Alban Landslide, near Quebec. Ill. (R G-June 29.) 1000 w.

23136. The Leslie Locomotive Fire Kindler (R G–June 29.) 1300 w.

23137. Settlement of Demurrage on the "24-Hour Average" Basis. A. M. Simmons (R G–June 29.) 1500 w.

23174. Brakeshoe Tests by the Master Car Builders' Association. Ill. (E N–June 28.) 1500 w.

23178. Steel-Tired Wheels in Use in the United States. Ill. (E N–June 28.) 300 w.

23180. Results of Tie Preservation by the Wellhouse Process (E N–June 28.) 500 w.

23257. War Upon the Public.—An Extensive Railway Strike Inaugurated under Pretense of Boycotting Pullman Cars (R A–June 29.) 2800 w.

23258. The Freight Bureau's Victory over Southern Railways (R A–June 29.) 1200 w.

23259. Year's Progress in Locomotive Construction. Ill. (R A–June 29.) 2200 w.

*23263. A Trip in Old Mexico. Ill. J. A. H. (L E–July.) 2000 w.

*23264. Block Signaling. Editorial. (L E–July.) 2000 w.

*23266. Science of Railroading. J. E. Phelan (L E–July.) 1500 w.

*23267. Uniform Air Pressure.—Letter from George Holmes (L E–July.) 1800 w.

23285. Nebraska's Apparent Hostility to Railroads. J. W. Johnson (From the Independent.) (R R–June 30.) 2300 w.

*23299. Report of Committee on Lubrication of Cars (N C B–July.) 4300 w.

*23300. Report of Committee on Ventilation of Passenger Equipment (N C B–July.) 3800 w.

23352. The International Railway Congress (E N–July 5.) 2600 w.

23355. Compressed Air and Hydraulic Machinery in Car Shops and Yards. Ill. (E N–July 5.) 1800 w.

23357. Forty Years' Decrease in Freight Rates. L. S. and M. S. Ry. (E N–July 5.) 400 w.

23367. Renewal of Drawbridge on the Jacksonville, Tampa and Key West Railroad. Ill. (R G–July 6.) 1500 w.

23368. English Experience of Train Lighting by Electricity. C. H. G. (R G–July 6.) 1800 w.

23369. Freight Car Statistics. (Extract.) W. W. Wheatly (R G–July 6.) 1200 w.

23371. Cost of Maintenance of Locomotives. Editorial (R G–July 6.) 1700 w.

*23424. Railway Development and Prospects. (I C T–June 29.) 1100 w.

23476. The Financial Folly of the Strike. Editorial (R A–July 6.) 600 w.

23477. The Great Strike—War of the "American Railway Union" on the Railways and the Entire Public (R A–July 6.) 5500 w.

23479. The Railroad Strike. Editorial (B D–July 7.) 1000 w.

Serials.

15496. Railroad Copper-smithing. Ill. John Fuller, Sr. (L E–Began Sept. 1893—9 parts to date—30 cts. each).

17826. The Evolution of the Air-Brake. Ill. Paul Synnestvedt (R E M–Began Dec.—7 parts to date—15 cts. each).

22399. Present Practice in Specified Loadings for Railroad Bridges. Ward Baldwin (R G–Began June 1—3 parts to date—15 cts. each).

22863. American Railway Car Couplers. Ill. (E–Began June 8—Ended June 29—4 parts—30 cts. each).

22869. The Enlargement of Liverpool Street Station, Great Eastern Railway. Ill. (Eng L–Began June 8—3 parts to date—30 cts. each).

22893. The Progressive Centralization of Power in the Federal Government. (From the Independent.) Aldace F. Walker, with Editorial. (R R–Began June 16—Ended June 23—2 parts—15 cts. each).

22918. The Early History of the Great Northern Railway. G. A. Sekon (R P L–Began June 1—1 part to date—30 cts).

STREET RAILWAYS.

22782. Budapest Electric Conduit Railway (E W–June 16.) 1000 w.

22788. Gas Motors for Street Railways—From report of William E. McKay (Sc A S–June 16.) 2500 w.

22814. Kinks in the Cable (M S P–June 9.) 900 w.

*22850. Tramway Traction in Newcastle-upon-Tyne (E E L–June 8.) 4500 w.

*22853. Cycle Railways: A New Departure in Cycling. W. Cave Thomas (Inv–June 9.) 900 w.

*22856. Motor Inspection. William M. Ramsey (S R R–June 15.) 800 w.

*22858. The Electric Railway as a Philanthropist (S R R–June 15.) 1000 w.

*22859. Time Tables and Train Schedules (S R R–June 15.) 700 w.

*22860. Operating Expense of the Intramural Electric Elevated Railway (S R R–June 15.) 1200 w.

*22861. A Cable Railway on the Ice. Ill. (S R R–June 15.) 750 w.

22903. Annual Report of the Budapest Electric Railway System (S R G–June 16.) 700 w.

22905. Steam and Electric Railways. Thomas L. Greene (S R G–June 16.) 1900 w.

*22917. How to Provide for the Increasing Suburban Traffic. G. A. Sekon (R P L–June 1.) 2000 w.

22964. Estimated Cost of Substituting Electricity for Cable on the Brooklyn Bridge (E E N Y–June 20.)700 w.

23075. Electric Railway Motor Tests. W. Nelson Smith (S R G–June 23.) 1800 w.

23139. Electrolysis—Its Causes and Cure (M S P–June 23.) 4200 w.

*23227. Hamburg Electric Railway. Ill. (E R L–June 22.) 1400 w.

†23338. Cincinnati and Its Street Railways. Ill. C. B. F. (S R J–July.) 10500 w.

†23339. The Electric Railway of Genoa, Italy. Ill. (S. R. J-July.) 1800 w.

†23340. The Wheel and the Rail. Ill. Fred H. Fitch (S R J-July.) 3500 w.

†23341. Hot Springs, Ark.; Memphis, Tenn. Ill. C. B. F. (S R J-July.) 5500 w.

23395. The Overhead Trolley System. O. M. Rau. (From Cassier's Magazine.) (E I-July.) 3300 w.

*23458. The Three-Wire System in Traction Work. Ill. E R L-June 29.) 700 w.

23464. Results of Electrolysis in St. Joseph, Mo. (S R G-July 7.) 1600 w.

23467. The Law of Negligence as Applied to Electric Street Car Collisions. R. D. Fisher (S R G-July 7.) 1200 w.

Serials.

18711. Electric Railway Motors; Their Construction and Operation. Nelson W. Perry (S R G-Began Jan. 6—26 parts to date—15 cts. each).

21747. Steam Tramway Locomotives. Ill. H. Conradi (R W-Began April—3 parts to date—30 cts. each).

22085. Metropolitan Railways of New York and London (R G-Began May 18—4 parts to date—15 cts. each).

23260. Electric Railway Conduit Systems. Ill. F. Jarvis Pattin (S R G-Began June 30—2 parts to date—15 cts. each).

SANITARY ENGINEERING.

*22654. The Chicago Drainage Channel and Waterway. Ill. George P. Brown (E Mag-Aug.) 3000 w.

*22721. Sewer and Drain Ventilation. W. W. West (S R-June 2.) 2500 w.

22907. A Study of Sewerage Assessments. Ill. (E R-June 16.) 2700 w.

22959. Lessons in Practical Plumbing. Ill. Grayson (S P-June 15.) 2300 w.

23020. The Chautauqua Sewage Disposal Works. Ill. (E R-June 23.) 1300 w.

23095.—75 cts. The Removal of Pathogenic Bacteria from Drinking Water by Sand Filtration. George W. Fuller (T Q-Dec.) 3600 w.

23096.—75 cts. The Metropolitan Sewerage System. Ill. Howard A. Carson (T Q-Dec.) 5500 w.

†23146. What German Cities Do For Their Citizens—A Study of Municipal Housekeeping. Albert Shaw (C M-July.) 9500 w.

*23160. Women and Sanitary Science. M. V. Shaler (Ch-July.) 1200 w.

23184. Method of House Drainage, Disposal of Waste and Ventilation (Met. W-June 30.) 1400 w.

23273. The Quality of Water Supplies. (Abstract.) John W. Hill (E R-June 30.)1600 w.

23390. Tests of Cement Sewer Joints. Ill. (E R-July 7.) 1400 w.

*23427. The Destruction of Refuse in a Destroyer on the Blast Furnace Principle (I & I-June 29.) 1800 w.

Serials.

5358. Sewage Purification in America. Ill. (E N-Began July 14, 1892—41 parts to date—15 cts. each).

14839. Water Purification in America (E N-Began Aug. 3, 1893—13 parts to date—15 cts. each).

21473. The Difficulties, Design and Economical Working of Dust Destructors (I & I-Began April 13—3 parts to date—30 cts. each).

22758. The Chicago Drainage Canal. Ill. (R R-Began June 9—4 parts to date—15 cts. each).

22995. Mechanical Heating and Ventilation. M. C. Huyett (I A-Began June—1 part to date—45 cts).

23275. Plumbing in Manhattan Life Insurance Building. Ill. (E R-Began June 30—1 part to date—15 cts).

23393. Ventilation of the National House of Representatives (E R-Began July 7—1 part to date—15 cts).

23410. The Heating and Ventilation of Large Buildings. Alfred R. Wolff (J F I-Began July—1 part to date—45 cts).

STEAM ENGINEERING.

*22674. Pump Valves (I & I-April 20.) 2500 w.

*22677. The Glasgow and West of Scotland Smoke Abatement Association (I & I-April 27.) 1500 w.

†22827. Errors of Measurements of Power by the Steam Engine Indicator. D. S. Jacobus (S In-April.) 3500 w.

22846. Boiler Inspection in New York City. W. B. Ruggles (S V-June 15.) 1600 w.

*22885. The Revival of the "Single" Engine. W. B. Paley (M W-June 8.) 1100 w.

22891. Corrosion in Steam Drums. Ill. (B J C-June 16.) 1500 w.

*22943. Early Steam Road Locomotives. Editorial (P Eng-June 8.) 2300 w.

*22946. The Grafton High-Speed Engine. Ill. Edward W. Anderson (P Eng-June 8.) 5000 w.

22966. Proper Connection of Steam Boilers and Engines (Abstract of Discussion presented by Theodore F. Scheffler.) (Ir Age-June 21.) 2100 w.

22997. Boiler Pumps. George Smail (S E-May.) 2000 w.

23022. Hot-Water Heating Apparatus in a Danbury, Conn., Church. Ill. (E R-June 23.) 1200 w.

*23070. The Indicator Card of the Oil Engine. Ill. J. F. Conradi (Eng L-June 15.) 1200 w.

23122. Mechanical Draft. Editorial (Ir Age-June 28.) 1200 w.

23183. Types of Heating Boilers in the United States. Arthur C. Walworth (Met W-June 30) 4500 w.

23187. Smoke Nuisance in Boston.—What

Is Being Done to Abate It (B J C-June 30.) 2800 w.

*23192. The External Corrosion of Steam Boilers. Ill. (M W-June 22.) 1600 w.

*23203. Liquid Fuel in the Future. R. Nelson Boyd (C G-June 22.) 3200 w.

23269. Moral Responsibility of Accidents in Steam Plants. Editorial (M G-June 30.) 1000 w.

23270. Heat Units and Specifications for Pumping Engines. Albert F. Hall (M G-June 30.) 3000 w.

*23401. Compression in Steam Cylinders. Editorial (Eng L-June 29.) 1400 w.

†23412. Smoke Preventing Appliances. W. F. Sicard (J F I-July.) 3500 w.

Serials.

17823. Designing Corliss Gears. Ill. James Dunlop (P Eng-Began Nov. 24, 1893—9 parts to date—30 cts. each).

18986. Boiler Calculations. James F. Hobart (S M-Began Jan. 15—8 parts to date—15 cts. each).

19709. The Indicator and Its Diagrams. Ill. Charles Day (P Eng-Began Feb. 2—13 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—5 parts to date—30 cts. each).

22874. Six German Steam Boiler Experiments with the Same Coal (Ruhr.) Ill. Bryan Donkin (Eng L-Began June 8—Ended June 15—2 parts—30 cts. each).

23251. National Boiler Insurance Company. Ill. Extract from Annual Report of Edward G. Hiller (P Eng-Began June 22—Ended June 29—2 parts—30 cts. each).

TELEPHONY AND TELEGRAPHY.

22779. The Invention of the Telegraph.—Letters from Stephen Vail and Edward L. Morse (E W-June 16.) 1100 w.

22781. The Kineto Phonograph. Ill. (E W-June 16.) 1200 w.

22789. Telephone Rates in Europe (Sc A S-June 16.) 500 w.

22980. A Method of Measuring Telephonic Currents and Electromotive Forces. Ill. Harris J. Ryan (E W-June 23.) 800 w.

22986. Growth of the Telephone Business (M S P-June 16.) 850 w.

22987. Speed of Ocean Telegraphy (M S P-June 16.) 1800 w.

†23011. Underground Telegraph Cables in West Africa (I R W-June 15.) 1000 w.

23013. Machine Currents and Railroad Telegraph Lines. J. W. Lattig (E A-June 23.) 800 w.

23014. The Telephone and the Railroad. Charles Selden (E A-June 23.) 1000 w.

23140. Batteries for Use with Telephones (M S P-June 23.) 900 w.

23308. The Load Line in Telephone Exchanges. Ill. A. V. Abbott, Jr. (E N Y-July 4.) 4000 w.

23314. How to Make Telephones and Telephone Calls. Ill. (Sc A S-July 7.) 2600 w.

23358. Invention of the Telegraph. Letter from Stephen Vail (E W-July 7.) 1200 w.

23374. Telephone Service on French Railroads. (Abstract.) G. Dumont (W E-July 7.) 800 w.

*23441. A Contribution to the Theory of Telephony. A. E. Kennelly (El-June 29.) 1800 w.

Serials.

23307. The Development of the Electric Telegraph. Stephen Vail (E N Y-Began July 4—1 part to date—15 cts).

MISCELLANEOUS.

22106. Mr. Balfour on Bimetallism. (Abstract.) (E M J-May 19.) 1800 w.

*22111. Records of Engineering Experience. Editorial (E-May 11.) 3500 w.

*22112. The Antwerp Exhibition. Editorial (E-May 11.) 3800 w.

†22129. Nicaragua and the Mosquito Coast. Ill. Robert N. Keely (P S M-June) 4000 w.

†22130. The Cincinnati Ice Dam. G. Frederick Wright (P S M-June.) 5500 w.

†22136. The Rubber Trade as Conducted in Pará. M. F. Sesselberg (I R W-May 15.) 4000 w.

*22143. Notes on Glass. Emma E. Everist (I C B-May 11.) 1800 w.

*22173. The Sources and Applications of Borax. E. L. Fleming (C T J-May 19.) 2000 w.

†22189. Topical Discussions and Interchange of Data. Ill. (A S M E-June.) 3500 w.

*22250. The University of Michigan—Ann Arbor (E-May 18.) 2200 w.

*22256. Farmers, Fallacies and Furrows. J. Sterling Morton (F-June.) 3700 w.

*22258. The Renewed Agitation for Silver Coinage: I. Need of an International Agreement. Franklin H. Head. II. The Folly of Further Agitation. Joseph C. Hendrix (F-June.) 9000 w.

*22273. Report of the Royal Commission for the Chicago Exhibition (J S A-May 18.) 30000 w.

22301. The Education and Production of Efficient Workmen. Henry Cribben (A Ar-May 26.) 3800 w.

22382. The Panama Scandal. Ill. Maurice Barrès (Cos-June.) 4000 w.

†22384. On a Mission for Kossuth. Ill. W. J. Stillman (C M-June.) 5800 w.

†22386. The Single Tax in Actual Application. Hamlin Garland (A-June.) 2500 w.

*22417. Engineers of To-Day—and Yesterday. James Henry Greathead. Ill. (E Rev-May 21.) 2000 w.

22432. The Indian Silver Experiment (E M J-June 2.) 1000 w.

*22524. Practical Training Schools. Editorial (I & I-May 18.) 1200 w.

†22531. The Geological Relations of the

Southern Appalachian Bauxite-Deposits. C. Willard Hayes (Tr A M E–June.) 3600 w.

†22537. The Bauxites: A Study of a New Mineralogical Family. Francis Laur (Tr A M E–June.) 3000 w.

†22539. The Torsional Theory of Joints. George F. Becker (Tr A M E–June.) 3000 w.

*22582. The Earthenware Industry in England.—Extract from Report of Wendell C. Warner (I S F–June.) 1600 w.

22583. American Sculptors. J. Q. A. Ward and His Work. Ill. (M N–June.) 1400 w.

*22590. Light and Heat Station of the University of Pennsylvania. Samuel B. Locke (E M–June.) 1800 w.

22612. The Excavations at Argos. Edward Robinson in Boston Evening Post (A & B–June 9) 1800 w.

22627. What are Atoms? Payton Spence (E A–June 9) 1500 w.

*22650. Our Enormous Annual Loss by Fire. Edward Atkinson (E Mag–Aug.) 3000 w.

*22660. The Supremacy of Britain's Trade. Editorial (E–June 1.) 2500 w.

†22662. A Reconnaissance of the Abandoned Shore Lines of the South Coast of Lake Superior. Ill. F. B. Taylor (A G–June.) 7500 w.

†22663. The Kames of the Otiskany Valley. T. W. Harris (A G–June.) 2500 w.

†22664. Lake Ronkonkoma and Other Glacial Features of Long Island. John Bryson (A G–June.) 900 w.

†22665. The Origin of Drumlins. Ralph S. Tarr (A G–June.) 5200 w.

†22705. Note on Some Appendages of the Trilobites. Ill. Charles D. Wolcott (G M–June.) 2500 w.

†22706. The Basic Eruptive Rocks of Grau (Norway) and Their Interpretation. A Criticism. H. J. Johnston-Lavis (G M–June.) 1200 w.

†22707. The Most Recent Changes of Level and Their Teaching.—The Raised Beaches. Henry H. Howorth (G M–June.) 3000 w.

†22741. Kidd's "Social Evolution."—Review by Lord Farrar (C R–June.) 5500 w.

†22742. Market Gambling. W. E. Bear (C R–June.) 7000 w.

†22743. The Race Problem in America. Charles F. Aked (C R–June.) 4800 w.

†22744. Bimetallists at the Mansion House. M. G. Mulhall (C R–June.) 2000 w.

22745.—75 cts. Monetary Standards. John Cummings (J P E–June.) 7200 w.

22772. Peter Cooper. Ill. (B & W–June.) 800 w.

†22775. Checks on Democracy in America. George Washburn Smalley (N C–June.) 7800 w.

†22776. Some Great Churches of France. II. Vézelay. Walter Pater (N C–June.) 3600 w.

†22800. Local Taxation—Its Amount and Burden. W. M. J. Williams (F R–June.) 8800 w.

†22823. The Bimetallist Agitation (B M–June.) 3000 w.

†22824. The New Taxes and the Graduation Principle. W. R. Lawson (B M–June.) 4400 w.

†22825. British Syndicates and Syndicating (B M–June.) 4200 w.

†22829. The Determination of the Calorific Power of Coals by Means of a Mahler Calorimeter. Ill. A. R. Leeds (S In–April.) 3000 w.

*22872. China and Her Progress. Editorial (Eng L–June 8.) 1700 w.

22909. Granite Beds Repaired with Type-Metal. Ill. (E R–June 16.) 800 w.

*22942. Power Distribution by Electricity, Water and Gas. Ed. C. de Segundo (G W–June 9.) 4600 w.

†22952. The Nationality Movement of the Nineteenth Century. John Downie (W R–June.) 5700 w.

†22953. Prosperity and Prices. Cecil B. Phipson (W R–June.) 7400 w.

22955.—$1. The Theory of Sociology. Franklin H. Giddings (An A A–July.) 13000 w.

22992. The California Midwinter Exhibition. Ill. (Sc A–June 23.) 1200 w.

22993. The Old University Building.—Its Once Distinguished Occupants (Sc A–June 23.) 1800 w.

†23006. A Visit to the Amazon Rubber Country. Ill. Hermann Reimers (I R W–June 16.) 1800 w.

†23007. Hand-Made vs. Machine-Made Hose (I R W–June 15.) 1100 w.

†23008. Do the Amazonian Rubber-Trees Grow on Uplands? Courtenay De Kalb (I R W–June 15.) 600 w.

†23009. The Use of Rubber Hose in Horticulture. C. L. Allen (I R W–June 15.) 1000 w.

†23010. Vulcanized Fibre as a Substitute for Hard Rubber (I R W–June 15.) 1800 w.

23017.—25 cts. Agriculture and the Tariff. Leonard Rhone and J. D. Weeks (A M & I W–June 22.) 1600 w.

23019. The American Propaganda at the Antwerp Fair (A & B–June 23.) 1800 w.

*23029. The Industries and Prospective Sources of Wealth in New South Wales. J. Inglis, with Discussion (J S A–June 15.) 8500 w.

*23032. Dr. Armstrong on the Publication of Scientific Literature (N–June 14.) 5000 w.

*23043. A Cycle Ride in Northern France.—The Festival of Ste Jeanne d'Arc at Orleans. Ill. (R of R–June 15.) 5000 w.

*23062. Power Distribution by Electricity, Water and Gas.—Discussion of paper by Ed. de Segundo (G W–June 16.) 2200 w.

*23064. Antonio Canova (A L–June 15.) 2500 w.

23100. The Art of Taking Casts. S. Bolland (F D–June 10.) 1800 w.

†23106. The Postal Service at New York Charles W. Dayton (N A R–July.) 3800 w.

*23117. The Kind of Money that Would Rule the World. M. D. Harter (F–July.) 2700 w.

*23189. Canadian Tariff Changes.—Taking Effect March 27, 1894 (B T J–June.) 6000 w.

*23190. Tariff Changes and Customs Regulations.—Russia, Sweden and Norway, Germany and Spain, France, Portugal, Italy, Roumania, United States, Mexico, Brazil, etc. (B T J–June.) 4800 w.

†23195. New and Little-Known Invertebrata from the Neocomian of Kansas. Ill. F. W. Cragin (A G–July.) 3500 w.

†23196. Causes and Conditions of Glaciation. Warren Upham (A G–July.) 2500 w.

†23197. The Present Condition of the Earth's Interior as Viewed from the Standpoint of the Nebular Hypothesis. W. H. Seamon (A G–July.) 1600 w.

†23198. Notes on Some Localities of Mesozoic and Paleozoic in Shasta County, California. Harold W. Fairbanks (A G–July.) 2000 w.

†23199. On a Recent Diamond Find in Wisconsin and on the Probable Source of This and Other Wisconsin Diamonds. W. H. Hobbs (A G–July.) 1000 w.

†23200. The Early Stages of Bactrites. Ill. John M. Clarke (A G–July.) 1800 w.

*23216. Engineers of To-day—and Yesterday. E. Windsor Richards. Ill. (E Rev–June.) 2000 w.

*23217. Public Works in the Australasian Colonies. R. Price-Williams (E Rev–June.) 1800 w.

*23223. The First Monopoly Patent (E–June 22.) 1600 w.

*23233. The Growth of Wealth in France and England (I C T–June 22.) 1300 w.

*23234. The Present and the Future of American Industry. Editorial (I C T–June 22.) 1350 w.

*23249. Decorative Art and Elementary Education. Selwyn Image, with Discussion (J S A–June 22.) 8400 w.

23262. The Doctrine of Bimetallism. Francis A. Walker (B I S–June 30.) 1350 w.

23288. I. Cotton Seed and Its Products. Ill. George F. Payne. II. The Various Stages of Reduction. Ill. III. Industrial Applications of Cotton Seed Oil. Robert Grimshaw (T–July 1.) 18500 w.

†23291. On the Occurrence of a Large Area of Nepheline Syenite in the Township of Dungannon, Ontario. Frank D. Adams (A J S–July.) 2800 w.

†23292. Tertiary Changes in the Drainage of Southwestern Virginia. Marius R. Campbell (A J S–July.) 3000 w.

†23293. On Some Methods for the Determination of Water. Ill. S. L. Penfield (A J S–July.) 2200 w.

†23294. The Upper Vicksburg Eocene and the Chattahoochee Miocene of Southwest Georgia and Adjacent Florida. A. F. Foerste (A J S–July.) 5200 w.

†23295. On Gabbros in the Southwestern Adirondack Region. C. H. Smyth, Jr. (A J S–July.) 4000 w.

†23296. Footprints of Vertebrates in the Coal Measures of Kansas. Ill. O. C. Marsh (A J S–July.) 1200 w.

†23297. The Typical Ornithopoda of the American Jurassic. Ill. O. C. Marsh (A J S–July.) 2000 w.

†23298. Eastern Division of the Miohippus Beds, with Notes on Some of the Characteristic Fossils. Ill. O. C. Marsh (A J S–July.) 1500 w.

23309. Steam and Electric Cable-Ways for Logging and Canal Boat Towing. Ill. Richard Lamb (E N Y–July 4.) 2600 w.

23354. The Prospects for Young Engineers—A Symposium, with Editorial (E N–July 5.) 9500 w.

†23362. On Money and Bimetallism. G. A. Russell (A P R–May 15.) 1700 w.

†23363. New South Wales Land Law. E. L. Du Faur (A P R–May 15.) 1600 w.

23365. Edward Atkinson Discusses Gold and Silver (M R–July 6.) 2700 w.

†23379. Monometallism and Protection. C. S. Thomas (A–July.) 4800 w.

†23380. India Silver, Wheat and Cotton. Samuel Leavitt (A–July.) 3500 w.

†23402. Wholesale Prices. A. E. (B M–July.) 1500 w.

†23403. The Bimetallic Agitation. J. P. Heseltine (B M–July.) 3800 w.

Serials.

18930. Carnot and Modern Heat. Oliver Lodge (Eng L–Began Jan. 5—13 parts to date—30 cts. each).

19052. Notes on the Manufacture of Ropes Ill. W. C. Popplewell (P Eng–Began Jan. 12—6 parts to date—30 cts. each).

21763. Engineering Practice and Education Gaetano Lanza (J F I–Began May—3 parts to date—45 cts. each).

22446. The Covered Markets of Europe. Marc Aurelio Boldi (E–Began May 25—Ended June 1—2 parts—30 cts. each).

22657. The Dry Method of Making Portland Cement. Chr. Engelhart (E–Began June 1—Ended June 22—3 parts—30 cts. each).

22687. On the Development of the Coach. Ill. Henry Stooke (I C B–Began June 1—1 part to date—30 cts).

22708. The Corrugation of the Earth's Surface and Volcanic Phenomena. Arthur Vaughan (G M–Began June—1 part to date—30 cts).

22848. Physical Units. Magnus Maclean (E E L–Began June 8—3 parts to date—30 cts. each).

23406. Notes on Russian Geology—The Black Earth. W. F. Hume (G M–Began July—1 part to date—45 cts).

We supply copies of these articles. See introductory.

THE·TECHNICAL·INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS index has been very properly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings, that within a few minutes, once a month, an active man can learn of everything of any importance that has been published during the month in relation to the subjects in which he is interested. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential improvement—namely: that in addition to indicating *just when and where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

IN ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents; those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents; and where the cost is above this, the price is given immediately after the number. In every case the price is closely regulated by the cost to us of a single copy of the publication from which the article is taken.

To avoid the inconvenience of small remittances and to cheapen the cost of articles to those who order frequently, we sell coupons at the rate of 15 cents each, or 15 for $2, 40 for $5, and 100 for $12.50. Each coupon is receivable in exchange for one 15-cent article; those marked * require two coupons; those marked † require three coupons; and for the articles of higher price, one coupon for each 15 cents: thus, a 75c. article requires five coupons. Samples of these coupons *will be sent free* for examination. They need only a trial to demonstrate their great convenience and economy.

[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. W=words.]

THE AMERICAN PRESS.

A.....Arena. *m.*. $5. Boston.
AA.....American Architect. *w.* $6. Boston.
Aer.....Aeronautics. *m.* $1. N. Y.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E.....Architectural Era. *m.* $3. N. Y.
A E R..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J P....Am. Jour. of Politics. *m.* $3. New York.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A M.....American Machinist. *w.* $3. New York.
Am A....Amer. Agriculturist. *m.* $1. N. Y.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am G....Amer. Gardening. *m.* $1. N. Y.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S M E.Am. Soc. of Mec. Eng. *m.*•New York.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B D.....The Black Diamond. *w.* $3. Chicago.
B & D....Builder and Decorator. *m.* $2. Minneapolis
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B U W...Bul. of the Univ. of Wisconsin.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A...Canadian Architect. *m.* $2. Toronto.
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23439. On Impulsive Current-Rushes in Inductive Circuits. Alfred Hay (El-Began June 29—4 parts to date—30 cts. each).

24090. The Various Methods of Charging the Public for Electricity from a Central Station. Alfred H. Gibbings (E R L-Began July 27—1 part to date—30 cts).

24198. Action of a Transformer with a Condenser in Parallel with the Secondary. Frederick Bedell and Albert C. Crehore (E W-Began Aug. 11.—1 part to date—15 cts).

ELECTRIC POWER.

23532. Water Supply Power and Electric Works at Zurich, Switzerland. Ill. (E N-July 12.) 2500 w.

23704. Thwaites Electric Power Transmission Scheme from the Coal Fields to London with Editorial. Ill. (E E N Y–July 18.) 4000 w.

23808. Electric Plants Driven by Gas Engines. Ill. (S. M–July 15.) 800 w.

23834. A Twelve Mile Transmission of Power by Electricity (Abstract.) Ill. Thomas H. Leggett. (E N–July 26.) 5800 w.

23857. Cost of Producing Electrical Energy. B. J. Arnold (W E–July 28.) 2200 w.

*23916. The Application of Small-Power Electric Motors, with Editorial. Ill. (El–July 20.) 2000 w.

23977. A New Departure in Electric Railway Power Houses. Columbus. Ill. (E R N Y–Aug. 1.) 700 w.

24025. Power Station Switch Boards. F. R. Slater (Pr–Aug.) 2500 w.

24061. The Modern Dynamo. Gilbert Donaldson (W E–Aug. 4.) 800 w.

*24138. Distribution of Electrical Energy by Alternating Currents. Ill. W. Lowrie's System (E E L–July 27.) 3800 w.

24186. The Use of Electric Motors for Driving Machine Tools (E N–Aug. 9.) 1600 w.

24197. Some Facts about Polyphase Motors. Louis Bell (E W–Aug. 11.) 3700 w.

Serials.

11560. Electric Motive Power. Ill. Albion T. Snell (El–Began March 17, 1893—17 parts to date—30 cts. each).

23628. Electrically Driven Mining Drills. Ill. J. W. Chubb (P Eng–Began July 6—Ended July 20—2 parts—30 cts. each).

23866. Electro-Dynamic Machinery. Edwin J. Houston and A. E. Kennelly (E W–Began July 21—2 parts to date—15 cts. each).

23868. Amateur Motor Building. Ill. G. E. Dunton (E W–Began July 21—2 parts to date—15 cts. each).

GAS ENGINEERING.

23514. The Liquefaction and Solidification of Air and Gases. Henry Wurtz (Sc A S–July 14.) 3800 w.

*23543. Discussion on Thomas Newbigging's Paper, on "Illuminating Power and Illuminating Effect" (J G L–July 3.) 8500 w.

*23544. Discussion on George Anderson's Paper on "Differental Charges for Gas" (J G L–July 3.) 3200 w.

*23545. Discussion on Dr. Voisey's Paper on "An Improvement in the Construction of Atmospheric Burners" (J G L–July 3.) 1800 w.

*23546. Notes on Gas Manufacture at Wallasey with Special Reference to Enrichment by Cannel. H. Ashton Hill (J G L–July 3.) 3500 w.

*23547. The Application of Coal Tar for Making Gas. C. Stafford Ellery (J G L–July 3.) 2400 w.

*23548. Construction and Working of Regenerator Settings of Retorts. W. R. Chester (J G L–July 3.) 3800 w.

*23549. An Improved Tar Extractor. Ill. F. D. Marshall (J G L–July 3.) 700 w.

23594. Electric Lighting vs. Gas. Edward M. Harris (A G L J–July 16.) 1300 w.

23596. The Relations between Gas Companies and Gas Consumers. William Paul Gerhard, in Cassier's Magazine (A G L J–July 16.) 4200 w.

*21633. Gaseous Fuel in the Retort House. T. S. Cleminshaw (G W–July 7.) 3000 w.

*23634. Special Applications of Gas. Ill. Norton H. Humphrys (G W–July 7.) 2200 w.

*23635. Gaseous Fuel. T. Travers (G W–July 7.) 3700 w.

*23636. Discussion of Paper by Frederick G. Dexter, on "Steam Applied as an Aid to the Revivification of Oxide of Iron in Situ" (G W–July 7.) 1600 w.

*23709. Discussion of Mr. Stelfox's Paper on "A First Season's Experience of Carburetted Water Gas" (J G L–July 10.) 4800 w.

*23710. Discussion of Mr. H. Ashton Hill's Paper on "Gas Manufacture at Wallasey, with Special Reference to Enrichment by Cannel" (J G L–July 10.) 2800 w.

*23711. Discussion of Mr. C. Stafford Ellery's Paper on "The Application of Coal Tar for Making Gas" (J G L–July 10.) 3200 w.

*23712. The Gas and Electricity Supply of Blackpool. William Chew (J G L–July 10.) 5500 w.

*23751. The Lighting of the Tower Bridge. Ill. (I & I–July 13.) 700 w.

*23788. My Experiences with Some Leaky Gasholder Tanks. Ill. J. Chadwick (G W–July 14.) 3200 w.

*23859. Discussion on the Papers by Messrs, Chester, Travers and Cleminshaw, on Regenerative Retort Settings and Gaseous Fuel (J G L–July 17.) 10000 w.

*23860. Discussion on Mr. W. Chew's Paper on "Gas and Electric Lighting at Blackpool" (J G L–July 17.) 3800 w.

*24001. Discussion of Mr. Chadwick's Paper on "My Experiences with Some Leaky Gasholder Tanks" (J G L–July 24.) 1600 w.

*24002. Young's Improvements in the Production of Illuminating Gas. Ill. (J G L–July 24.) 4300 w.

24003. Enrichment of Coal Gas. Alexander C. Humphreys (P A–Aug. 1.) 3000 w.

24004. Welsbach Incandescent Burners. E. G. Love (P A–Aug. 1.) 1400 w.

24024. A Three Hundred Horse-Power Gas Engine Plant. Ill. (Pr–Aug.) 1000 w.

*24101. A Natural Gas Forge (I C B–July 27.) 900 w.

Serials.

13534. The Gas Engine. Ill. (M W–Began June 2, 1893—10 parts to date—30 cts. each).

23209. Recent Improvements in the Utilization of Gas (G W–Began June 23—Ended July 14—3 parts—30 cts. each).

23473. Distribution of Gas. J. P. Gill (A G L J–Began July 9—Ended July 16—2 parts—15 cts. each).

HYDRAULICS.

23528. A Test of the Pohlé Air-Lift Pump at De Kalb, Ill. Ill. L. B. Merriam (E N–July 12.) 1500 w.

†23552. Canal Discharges in the Kistna Delta. Alfred Chatterton (I E–June 9.) 1600 w.

23568. A Disastrous Well (E R–July 14.) 1500 w.

23580.—$1.50. Dredging Operations.—Discussion on paper, "Reclamation of the Potomac Flats," by Peter C. Hains (T C E–May.) 5000 w.

23585—$1.50. Discussion on paper of Joseph P. Frizell, on "Storage and Pondage of Water" (T C E–May.) 800 w.

*23640. Waterworks Engineering (B–July 7.) 3800 w.

23684. Deep Well Pump Balancing. W. H. Booth (A M–July 19.) 1000 w.

23722. Water Power of the Falls of the Missouri, Great Falls, Mont. M. S. Parker (E N–July 19.) 1200 w.

23727. The Filter Question at Providence (E N–July 19.) 1500 w.

23730. The Reinforcement of Deficient Water Supply in Wells. Ill. G. D. Hiscox (Met W–July 21.) 1600 w.

23746. The Law of Water Ownership. W. A. Hancock, in Irrigation Age (F W–July 21.) 1600 w.

23831. Canals and Land Drainage and Reclamation in Florida. J. Francis Le Baron (E N–July 26.) 4700 w.

23897. Cleaning Corroded Water Mains. Ill. (E R–July 28.) 950 w.

*23917. The Devastation of Nubia. Somers Clarke (B–July 21.) 5700 w.

*23943. New Formulas for Calculating the Flow of Water in Pipes and Channels. William E. Foss (J A E S–June.) 3000 w.

†23945. The Baptism of the Great Niagara Tunnel. Emile Geyelin (P E C P–April-June.) 3500 w.

24015. The Catastrophe at Lima, Montana. J. M. Goodwin (Sc A S–Aug. 4.) 1400 w.

24016. The Draining of the Zuider Zee. Ill. (Sc A S–Aug. 4.) 2300 w.

24068. Nebraska Water Supply. A. R. McKay (F W–Aug. 4.) 1600 w.

24175. Scientific Irrigation.—Its Wonderful Progress in America and Its Benefit to Mankind. Ill. (I Age–Aug.) 1400 w.

24187. Repairs to the Maligakanda Service Reservoir, Colombo, Ceylon. Ill. Henry Ewart (E N–Aug. 9.) 5800 w.

Serials.

18801. Discharge of Sluices and Weirs under Varying Heads. G. C. Maconchy (I E–Began Dec. 9—15 parts to date—45 cts. each).

21433. Glasgow Water Works. Ill. (E–Began April 13—Ended July 13—7 parts—30 cts. each).

22670. The Danube Regulation Works. Ill. Bela von Gonda (Eng L–Began June 1—3 parts to date—30 cts. each).

23279. What a Water Supply Engineer Can Do in the Fire Department. James E. Tryon (F W–Began June 30—3 parts to date—15 cts. each).

23641. Details of Rural Water Supply (B–Began July 7—4 parts to date—30 cts. each).

23669. Centrifugal Pumps. John Richards (I S F–Began July—2 parts to date—30 cts. each).

INDUSTRIAL CHEMISTRY.

†24069. The Accuracy of the Commercial Assay for Silver. Frederic P. Dewey (J A E S–Aug.) 2200 w.

†24071. The Volumetric Determination of Phosphorus in Steel. W. A. Noyes and E. D. Frohman (J A E S–Aug.) 2200 w.

Serials.

19453. Contributions to the Chemistry of India-Rubber. P. Carter Bell (I R W–Began Jan.—5 parts to date—45 cts. each).

24076. Theory and Practice of Refrigeration I & I–Began July 27—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY.

†23538. Incidents of Labor War in America. W. T. Stead (C R–July.) 5500 w.

†23540. Employers' Liability. A. D. Provand (C R–July.) 8000 w.

23576. Lords of Misrule. Editorial (A M & I W–July 13.) 1000 w.

23579. The Law of Riot. Editorial (A S–July 14.) 900 w.

23616. The Recent Coal Strike.—The Effects, and Some Facts It Has Demonstrated. William M. Brewer (T–July 15.) 2200 w.

†23657. The Failure of the Labor Commission. Mrs. Sidney Webb (N C–July.) 10200 w.

23674. The Soft Coal Strike. Henry Bland (S V–July.) 1600 w.

†23679. Working-Class Settlements in Mulhouse and Milan. Charles Hancock (F R–July.) 5000 w.

23735. Benefits Derived from the Late Strike. Editorial (B J C–July 21.) 1200 w.

*23758. Workmen's Pension and Profit-Sharing Funds. Editorial (E–July 13.) 3500 w.

23784. New Zealand Labor Laws. John D. Connolly (R R–July 21.) 1600 w.

23809. The Industrial Belligerents. Editorial (S M–July 15.) 2000 w.

23815. Demagogues Astray. A. B. Salom (I I G–July.) 1100 w.

23835. Side-Lights on the Strike (R G–July 27.) 2200 w.

*23941. A Post Mortem Examination.—The American Railway Union. Editorial (N C B–Aug.) 1200 w.

†23959. The Lesson of the Recent Strikes I. Nelson A. Miles. II. Wade Hampton. III Harry P. Robinson. IV. Samuel Gompers (N A R–Aug.) 10800 w.

†23960. English Workmen and Their Political Friends. John E. Gorst (N A R–Aug.) 4400 w.

23967. The Wages of Labor. Editorial (M I T–July 26.) 1000 w.

*23990. After the Battle.—The Strike. Editorial (A E R J–Aug.) 5200 w.

*24087. Modes of Sharing the Proceeds of Industry.—From the Report of the Royal Commission on Labor (C G–July 27.) 6200 w.

24105. A Successful Arbitration (A A–Aug. 4.) 1200 w.

24116. Organized Labor's Rights.—From the N. Y. Law Journal (Eng–Aug. 4.) 1000 w.

24157. The Obligation of Public Service. Editorial (R R–Aug. 4.) 900 w.

LANDSCAPE ENGINEERING.

23508. The Aesthetic Value of Roads and Walks. H. A. Caparn (G & F–July 11.) 1200 w.

23700 The Use of Color in Our Parks (G & F–July 18.) 1800 w.

23701. The Gardens of the Early New England Colonists. Daniel Denison Slade (G & F–July 18.) 1300 w.

24161. The Harlem River Speedway (G & F–Aug. 8.) 1200 w.

MARINE ENGINEERING.

23501. Screw Ferry Steamer "Pleasure." Ill. (A M–July 12.) 1800 w.

23504. Vigilant vs. Britannia. Editorial (Sea–July 12.) 700 w.

23536. The Nicaragua Canal.—Its Great Value to the Country. Letter from Richard B. Hubbard, and opinions of Southern Editors (M R–July 13.) 4500 w.

23565. The First Trip by Steam from the Atlantic to the Lakes (E R–July 14.) 900 w.

†23602. The Problem of the Pole. Charles Morris (N S R–July.) 6000 w.

*23605. The Marine Interests of Italy (Tr–July 6.) 1300 w.

*23609. The Thames and Boulogne Excursion Steamer "La Marguerite." Ill. (E–July 6.) 1400 w.

23720. Constructing the "Rhumb" and Correcting the Courses of Ships. H. C. Pearsons (Sea–July 19.) 2000 w.

23721. Senator Walsh's Views on the Nicaragua Canal (M R–July 20.) 1500 w.

*23762. The Action of Screw Propellers. Ill. M. J. A. Normand (E–July 13.) 1800 w.

23782. Marine Engineers and Railway Engineers (M Rec–July 19.) 800 w.

*23883. In the Engine-Room of the "Lucania." Ill. (Eng L–July 20.) 4200 w.

*23889. On the Amplitude of Rolling on a Non-Synchronous Wave. M. E. Bertin (E–July 20.) 3300 w.

*23938. The Yachts and Yachtsmen of America. Review of book Edited by Henry A. Mott (Tr–July 20.) 1800 w.

†23994. Madras Harbor. Ill. (I E–June 30.) 700 w.

24011. Bersier's Steering Compass. Ill. (Sc A–Aug. 4.) 1600 w.

24052. Why the South Needs the Nicaragua Canal. Courtenay DeKalb, with Editorial (M R–Aug. 3.) 2600 w.

*24078. On the Importance of Economy of Fuel in Very Fast Vessels. J. A. Normand (I & I–July 27.) 1100 w.

*24080. The Nicaraguan Canal. Editorial (I & I–July 27.) 1000 w.

*24081. On the Harbor and Docks of Southampton. Ill. Mr. Dixon (Eng L–July 27.) 2500 w.

*24082. The Ventilation of Steamships and Bulk Oil Steamers. Stephen H. Terry and Fortescue Flannery (Eng L–July 27.) 1200 w.

24106. Antarctic Explorations (M Rec–Aug. 2.) 1700 w.

*24149. The Ports of China and Corea (Tr–July 27.) 2500 w.

*24151. A Year's Losses at Sea (Tr–July 27.) 1600 w.

24191. The New Ocean Steamers, St. Louis and St. Paul. Ill. (Sc A–Aug. 11.) 1200 w.

Serials.

16636. Marine Engine Design. Ill. (M W–Began Oct. 6—12 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E–Began April 14—10 parts to date—45 cts. each).

22599. Forced and Induced Draught as Applied to Marine Boilers (M W–Began June 1—Ended July 6—4 parts—30 cts. each).

23761. The Vibrations of Steamships. John H. Macalpine and H. C. Flood (E–Began July 13—2 parts to date—30 cts. each).

MECHANICAL ENGINEERING.

*23484. The Modern Mechanical Drawing-Room. C. W. MacCord (E Mag–Sept.) 3000 w.

*23489. The Management of Men in Mills and Factories. W. H. Wakeman (E Mag–Sept.) 3000 w.

23500. Forging Lathe Tools. Ill. B. F. Spalding (A M–July 12.) 3000 w.

*23610. Drawing Office Methods. S. E. McNair (E–July 6.) 1500 w.

23732. An Ancient Automaton (B J C–July 21.) 1100 w.

23827. A New Recording Pressure Gauge for Extremely High Ranges of Pressures. Wm. H. Bristol, with Discussion (A M–July 26.) 1400 w.

23863. About Loose Pulleys (B J C–July 28.) 1100 w.

†23947. The First United States Pneumatic Postal System. Ill. A. Falkenau (P E C P–April–June.) 5500 w.

24023. Human Nature in the Machine Shop. Frank Richards (A M–Aug. 2.) 1300 w.

*24072. The Manchester Meeting of the Institution of Mechanical Engineers.—Account

of Some of the Works Which May Be Considered as Representive of the Manchester District. Ill. (E-July 27.) 46500 w.

24127. Portland Cement (A G L J-Aug. 6.) 1500 w.

*24133. A Practical Method of Striking Arcs of Large Radius. Ill. Herbert Aughtie (P Eng-July 27.) 700 w.

*24136. Wind Motors Ancient and Modern. Sidney H. Hollands (P Eng-July 27.) 4000 w.

*24141. Remarks on the Patent System. John Richards (I S F-Aug.) 2500 w.

Serials.

17362. Arithmetic of the Screw and of Symmetrical Rings. Leicester Allen (A M-Began Nov. 16—5 parts to date—30 cts. each).

17900. Machine Ship Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7—11 parts to date—15 cts. each).

18044. Motive Powering and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1—19 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M-Began Feb.—5 parts to date—30 cts. each).

20171. Practical Notes on Rope-Driving. Ill. M. E. (S R J-Began March—3 parts to date—45 cts. each).

23498. Notes on the Theory of Shaft Governors. Ill. Albert K. Mansfield (A M-Began July 12—Ended July 19—2 parts—15 cts. each).

23937. Some Practical Hints in Dynamo Design. Gilbert Wilkes (S R G-Began July 28—1 part to date—15 cts).

24173. The German Patent System. Gustav Bissing (E.R N Y-Began Aug. 8—1 part to date—15 cts).

METALLURGY.

*23483. The Cyanide Process of Gold and Silver Extraction. Philip Argall (E Mag-Sept.) 3000 w.

23506. Permeability of Steel. Ill. Max Osterberg and Milbourne Munroe (E W-July 14.) 700 w.

23534. What Thomas A. Edison Is Doing. (From the N. Y. Sun.) (B I S-July 12.) 900 w.

23572. The Secret of Steel.—One of Its Early Discoverers (B J C-July 14.) 800 w.

23575. Modern Steel Plants. Ill. Ernst Prochaska (A M & I W-July 13.) 800 w.

23589. Concentration of Copper Ores on Lake Superior. (Abstract.) Fred. Fraley Sharpless (E M J-July 14.) 1000 w.

*23612. Separating Mixed Ores. Walter J. May (C G-July 6.) 950 w.

*23621. The Colossus of the Iron-Making World. The Carnegie Company (I C T-July 6.) 2800 w.

23687. System for Foundry Orders. F. B. Schaffer (A M-July 19.) 400 w.

23691. Dolomite as a Flux for Blast Furnace Use. E. O. Uehling (Ir Age-July 19.) 600 w.

23692. Hardening Composite Plates for Bank Vaults. Ill. (Sc A-July 21.) 900 w.

23724. Rustless Coatings for Iron and Steel (E N-July 19.) 2800 w.

23731. Dressing Iron Ore in Spain. (Abstract.) Frederick Kensington (A M & I W—July 20.) 1500 w.

23739. The Utilization of Waste Heat Contained in Slags from Smelting Furnaces. Ill. John Howell and E. A. Ashcroft (E M J-July 21.) 1000 w.

*23748. The Smelting and Bessemerizing of Copper Ores Ill. (C T J-July 14.) 1000 w.

*23778. Electricity in the Iron Industry (I C T-July 13.) 1200 w.

23820. Conveniences in the Foundry. H. Hansen (F D-July.) 2000 w.

23821. Some Modern Bronzes. James Larkin (F D-July.) 4500 w.

*23879. On the Determination of Phosphorus in Iron and Steel (I & I-July 20.) 800 w.

23926. Wrought Iron Work: Medieval and Modern. J. Starkie Gardner (A & B-July 28.) 4500 w.

23979. Report on the Working of a Siemens Furnace (Ir Age-Aug. 2.) 2200 w.

23980. Apparatus for Breaking Pig Iron. Ill. John S. Kennedy (Ir Age-Aug. 2.) 900 w.

23981. An Economical Cupola. Ill. F. B. Whitcomb, with Discussion (Ir Age-Aug. 2.) 1400 w.

*23997. The Bessemer Steel Industry: Past and Present. Henry Bessemer (E Rev-July.) 2000 w.

24053. Treatment of Gold Ores.—The Murphy Process. Ill. (M R-Aug. 3.) 2800 w.

†24070. The Commercial Valuation of Lead-Tin and Lead-Antimony Alloys. Joseph W. Richards (J A E S-Aug.) 700 w.

24115. Old Gold and How It Is Refined (Eng-Aug. 4.) 1400 w.

24126. Dolomite as Blast Furnace Flux (I T R-Aug. 2.) 700 w.

*24145. Bohemian Basic Steel as a Bridge Building Material. A. Vavra (I & S-July 28.) 1300 w.

*24146. Influence of Heat on the Tenacity of Metals. M. Rudeloff (I & S-July 28.) 900 w.

*24160. Alloys. J. T. Hewitt (C T J-July 28.) 2200 w.

24172. Aluminum: Its Properties and Its Uses (M & B-June.) 6000 w.

Serials.

21201. Lacquer and Bronze Work. William Norman Brown (Pl D-Began April—Ended July—4 parts—30 cts. each).

21369.—Press Working of Sheet Metals. Ill. Oberlin Smith (Ir Age-Began April 19—4 parts to date—15 cts. each).

21814. Plate-Moulding. Ill. J. Horner (P Eng-Began April 27—5 parts to date—30 cts. each).

22710. Science for Ironmongers (Iron-Began June 2—6 parts to date—30 cts. each).

22854. The Dry Assay of Ores (I & I-Began June 8—6 parts to date—30 cts. each).

23162. Iron-Making at Birmingham, Ala. Edmund C. Pechin (E M J-Began June 30—4 parts to date—15 cts. each).

23551. Malleable Iron Castings. S. Bolland (M W-Began July 6—Ended July 13—2 parts—30 cts. each).

23685. Calculating Weights for Estimates. Ill. Joseph Horner (A M-Began July 19—1 part to date—15 cts).

23846. A New Method of Smelting Iron Pyrites, etc. Messrs. Fraser and Chalmers (M J-Began July 14—Ended July 21—2 parts—30 cts. each).

24075. The Manufacture of Tin Plates (I & I-Began July 27—1 part to date—30 cts).

24088. The Analysis of the Quantity of Carbon in Iron (C G-Began July 27—1 part to date—30 cts).

24170. Bulk Chlorination of Gold Ores. W. H. Gaze (A M S-Began July 7—1 part to date—30 cts).

24183. Blowing Engines.—Discussion on paper by Julian Kennedy (A M-Began Aug. 9—1 part to date—15 cts).

MILITARY ENGINEERING.

23530. Tests of Rapid-Fire Guns at Sandy Hook (E N-July 12.) 800 w.

23533. Carnegie Armor: Facts against Theories (B I S-July 11.) 2400 w.

23541—75 cts. A New Method of Indirect Laying for Field Artillery. Ill. Heinrich Edler von Brilli (J U S A-July.) 9000 w.

23542. The Army and Public Sentiment. Editorial (A & N J-July 14.) 1200 w.

†23678. A Lesson from the "Chicago." Nauticus (F R-July.) 5500 w.

23695. The Passage of Rivers by Cavalry (Sc A S-July 21.) 2000 w.

23745. Armor Plate Inspection (A & N J-July 21.) 1800 w.

*23776. Smokeless Powders (Inv-July 14.) 1600 w.

†23957. Sea Power of the United States. Charles H. Cramp (N A R-Aug.) 5400 w.

†23958. Civil Wars in South America. Estanislas S. Zeballos (N A R-Aug.) 3500 w.

24012. The Modern War Gun. Ill. (Sc A S-Aug. 4.) 1200 w.

24029. Outflanking Two Emperors. Ill. Murat Halstead (Cos-Aug.) 4500 w.

24030. The English Napoleon. Ill. J. Howe Adams (Cos-Aug.) 3200 w.

*24074. Meeting of the Institution of Naval Architects (E-July 27.) 8000 w.

Serials.

21991. The New Spanish Belted Cruisers. Ill. (E-Began May 4—Ended July 6—5 parts—30 cts. each).

23750. Cast-Iron, Steel-Hooped, Rifled Breech-Loading Mortars for United States Coast-Defense. Ill. (I & I-Began July 13—3 parts to date—30 cts. each).

23775. The Traction Engine for Military Purposes: or "Steam Transport on Roads." Lieut.-Col. Templar (Inv-Began July 14-Ended July 21—2 parts —30 cts. each).

23796. Naval Dynamo Machinery. (E R L-Began July 13—1 part to date—30 cts.)

MINING.

*23520. Marble, Its Measurement and Market. George C. Underhill (S-July.) 2200 w.

*23521. A Successful Slate Syndicate. Ill. (S-July.) 400 w.

*23522. The Evolution of the Slate Industry (S-July.) 900 w.

23587. The Coal Production of the World (E M J-July 14.) 1000 w.

†23601. Diamonds and Gold.—Anglo-Saxon Supremacy in South Africa. F. I. Ricarde-Seaver (N S R-July.) 4500 w.

*23613. New Theory as to Firedamp Explosions (C G-July 6.) 4300 w.

*23663. A Neglected Gold-field.—Solferino, N. S. W. (A M S-May 26.) 800 w.

*23664. Mount Huxley, Tas. (A M S-May 26.) 800 w.

*23665. A Talk About Indicators. F. D. Johnson (A M S-June 2.) 1000 w.

*23667. The Mineral Fields of Western Australia (A M S-June 9) 1200 w.

*23668. Mallacoota—A New Victorian Goldfield (A M S-June 16.) 1500 w.

23670. Placer Mining in Alaska. Ill. (M S P-July 7.) 2800 w.

23671. Mariposa as a Mining County (M S P-July 7.) 1500 w.

23688. Notes on Fan Efficiencies. William Sangster (A M-July 19.) 1200 w.

23694. Quicksilver Mining in Tuscany (Sc A-July 21.) 750 w.

23738. The Boise Basin in Idaho. J. B. Hastings (E M J-July 21.) 1000 w.

23740. Shaft Sinking with the Aid of Divers. (Abstract.) Ill. G. Nordenstrom (E M J-July 21.) 1200 w.

*23747. English Mines and Miners. Ill. S. Parkes Cadman (Ch-Aug.) 3300 w.

*23777. Are American Coal Imports Probable? Walter J. May (Inv-July 14.) 1500 w.

23794. The Southern Coal Industry Grows (B D-July 21.) 1100 w.

23803. Resume of the Mineral Industry of California for 1893. J. J. Crawford (M S P-July 14.) 4000 w.

23805. Mining Districts of Mariposa County (M S P-July 14.) 2500 w.

23823. California's Borax Mines (Sc A-July 28.) 1100 w.

23825. American "Tripoli." Ill. E. O. Hovey (Sc A S-July 28.) 900 w.

23828. Drift Mining in California (M S P-July 21.) 700 w.

*23847. The Manganese Mines of Las Cabesses, Pyrenees, France (M J-July 14.) 1500 w.

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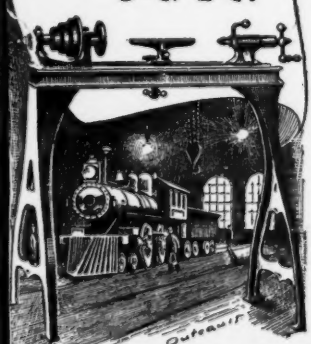

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ELECTRICAL SCIENCE UP TO DATE—
Lessons of the Richmond Electric Railway. FRANK J. SPRAGUE.
Tesla's Discoveries in Electricity. NELSON W. PERRY.

The Cyanide Process of Extraction—
For Gold and Silver Ores. PHILIP ARGALL.

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2—Seating, Lighting, Heating, Decoration. DANKMAR ADLER.

The Present Condition of the Panama Canal—
A Disinterested Investigation. OSCAR A. F. SAABYE.

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Advantages and Disadvantages Considered. R. H. THURSTON.

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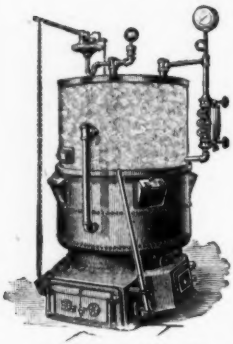

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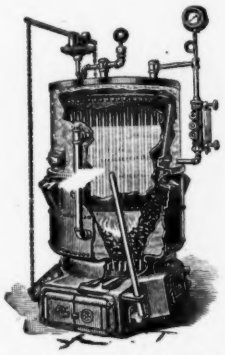

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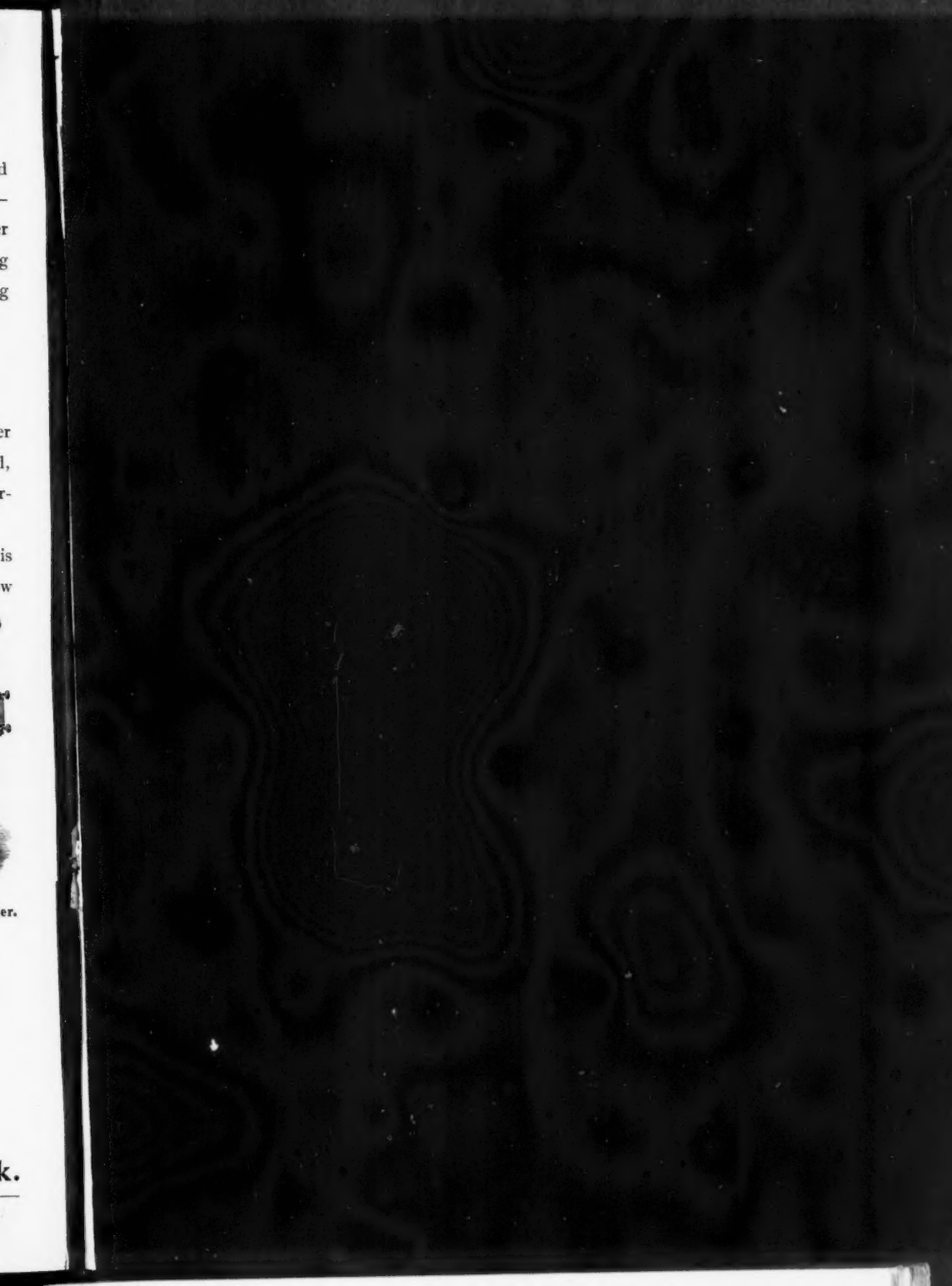

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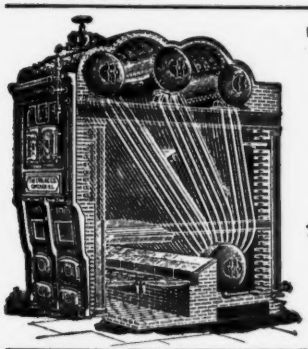

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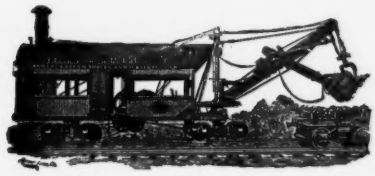

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A WORD OF INTRODUCTION.

AUTHORS AND PAPERS THIS MONTH.

EDMUND MITCHELL (*The International Exhibition at Antwerp*)=Was born in Glasgow in 1861; took the degree of M. A. in Aberdeen University; entered the profession of journalism in Glasgow; was later an editor successively in Bombay, Calcutta, and Melbourne; at Chicago had charge at the World's Fair of the important wool exhibit from Victoria; is now visiting the Antwerp exhibition as a journalist.

OSCAR SAABYE (*The Present Condition of the Panama Canal*)=Was born in 1852; was graduated from the University of Copenhagen, taking the degree of A. B. in 1870 and C. E. in 1874; practised the profession of civil-engineer in Europe and India; came to the United States in 1876 and became actively engaged in railway work; in 1893–94 made a survey for a gold-mining company at Cachavi, Ecuador, stopping on his return to the United States to examine the Panama canal.

NELSON W. PERRY (*Nikola Tesla and His Work*)=Was graduated as Engineer of Mines at the School of Mines, Columbia College, in 1878, and pursued an active career in the profession of mining engineering; after ten years he devoted himself to electrical engineering, and has become especially well known in the electrical field through his connection as editor with *Electricity* and the *Electrical World*; is a member of the American Institute of Electrical Engineers.

ROBERT H. THURSTON (*The Use of Stationary Compound Engines*)=Was born Providence, R. I., October 25, 1839; was graduated from Brown University (1859) from which he received the degree of LL. D.; was for ten years in the United States Naval engineers; was in active service throughout the war; assisted in organizing the Stevens Technical Institute and was fourteen years professor of engineering there; accepted in 1885 his present position of director of the Sibley College of Mechanical Engineering at Cornell University; first president (1880–82) American Society of Mechanical Engineers; is a member of many other learned societies; has written much on the steam-engine and other subjects.

PHILIP ARGALL (*The Cyanide Process of Gold and Silver Extraction*)=Mining engineer and metallurgist; born near Belfast, Ireland, in 1854; received his first mining experience at the Avoca pyritic mines, near Dublin; thence he went to Swansea, Wales, and engaged in the smelting business; managed an antimony smelting-works in London for some time, thence proceeding to New Zealand to engage in gold-mining; traveled for some time in Australia; next engaged in mining and metallurgical works in Mexico; from there he went to France; was engaged as manager of the La Plata Mining and Smelting Co. at Leadville, 1887–92; now located at Denver, Col.; member Royal Irish Academy and other scientific and technical societies.

DANKMAR ADLER (*Theater-Building for American Cities—II*)=A member of the Chicago architectural firm of Adler & Sullivan, who was more fully referred to on this page last month.

FRANK J. SPRAGUE (*The Lessons of the Richmond Electric Railway*)=Was graduated at Annapolis and entered the United States navy; he early turned his attention to electricity and in 1883 he left the navy to enter the construction department of Mr. Edison's works, taking up the subject of the electrical transmission of power; he next joined Mr. E. H. Johnson in the same line of work; he exhibited at the Philadelphia electrical exhibition in 1884 a number of motors which marked a distinct advance in motor construction; in 1885 the Sprague Electric Railway and Motor Co. was formed to manufacture stationary motors, but Mr. SPRAGUE soon turned his attention to railway motors; he took the contract for the Richmond (Va.) electric street-railway, the first commercially successful road of the kind built; the Sprague company was absorbed by the General Electric Co., Mr. SPRAGUE remaining with the latter for some time as consulting engineer; he has since been a member of the Sprague Electric Elevator Co., and of a firm of consulting electrical engineers; has been connected with many of the largest electrical engineering undertakings on this side of the Atlantic; was president (1892-93) of the American Institute of Electrical Engineers.

TER. M. UYENO (*Commercial Aspect of the Japan-China War*)=Was born in Kanasawa, Province of Kaga, Japan, when the Feudal system was in existence; was brought up a *Samurai*, whose motto was "sword is mightier than pen," not "pen is mightier than sword" and whose principle was to sacrifice life for his lord; after the revolution he was admitted to the military academy of the province under English system; he learned English in Japanese government schools; studied English law in the Imperial University of Tokio, Japan; was official English interpreter and secretary to the Judicial court at Kohe; served the United States government for four years as the official consular interpreter and secretary at Kohe (Hiogo); represented a Japanese raw-silk house in New York in 1884-86; on returning to Japan, contributed articles on Japan to various American newspapers; was in business in Yokohama, dealing with various houses in Europe and America; is now a member of the firm of Takaki & Co., importers of Japanese raw silk, in New York.

C. W. MACCORD (*The Modern Mechanical Drawing-Room*)=Was born in Dutchess county, N. Y., March 18, 1836; was graduated at Princeton in 1854; received the degree of Sc. D. from same college in 1881; was chief draughtsman for Captain John Ericsson for nine years; afterwards acted in the same capacity on the Stevens battery and in the Dock Department in New York under Gen. George B. McClellan; since 1871 he has been professor of mechanical drawing in the Stevens Institute of Technology at Hoboken; is the author of many mechanical books of value.

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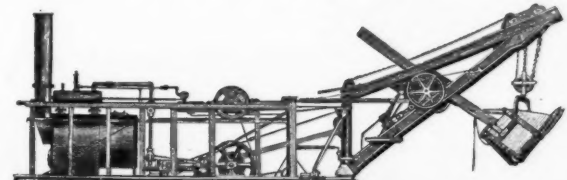

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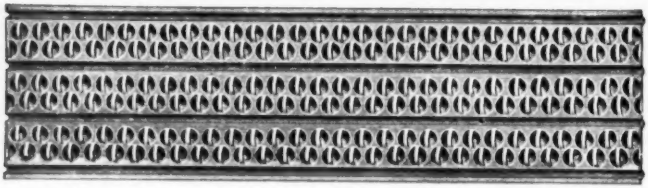

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Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Chester Steel Castings Co., Philadelphia, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Pelham Machine Works, 416 W. 26th St., N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Link Belt Engineering Co., Phila., Pa.
Pennsylvania Machine Co., Philadelphia, Pa.

Corliss Engines.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J
M. C. Bullock Mfg. Co., Chicago, Ill.
C. & G. Cooper Co., Mt. Vernon, Ohio.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
James A. Miller & Bro., Chicago, Ill.
Niles Iron & Steel Roofing Co., Niles, Ohio.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chester Steel Castings Co., Philadelphia, Pa.
Chrome Steel Works, Brooklyn, N. Y.

Crushers, Ore, Phosphate Rock.

American Road Machine Co., Kennett Square, Pa.
Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Beckett Foundry and Machine Co., Arlington, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y
Geo. T McLauthlin & Co., Boston, Mass.
Sturtevant Mill Co., Boston, Mass.

Damper Regulators.

Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Desks

A. H. Andrews & Co., Chicago, Ill.

Diamond Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N.Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

E. W. Bliss Co., Brooklyn, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chester Steel Castings Co., Philadelphia, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Disinfecting Machinery.

Geo. T. McLauthlin & Co., Boston, Mass.

Drawing Instruments.

Brandis Sons Co., Brooklyn, N. Y.
E. L. Deane, Holyoke, Mass.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Drawing Presses.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Dredging Machines.

Bucyrus Steam Shovel & Dredge Co., S. Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

W. F. & J. Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Dwight Slate Machine Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Waterman Machine Tool Co., Providence, R. I.

Drop Forgings.

Billings & Spencer Co., Hartford, Conn.

Drop Presses.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Dynamos.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

General Electric Co., 44 Broad St., N. Y.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
W. P. Harrison & Co., Columbus, Ohio.
Interior Conduit & Insulation Co., New York.
Queen & Co., Inc., Philadelphia, Pa.
Standard Thermometer Co., Peabody, Mass.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
Newton Rubber Works, Boston, Mass.
Spinney, Virtue & Co., Lynn, Mass.

Elevators, Steam, Hydraulic, Electric.

Graves Elevator Co., Rochester, N. Y.
Geo. T. McLauthlin & Co., Boston, Mass.
Morse, Williams & Co., Philadelphia, Pa.
Springfield Foundry Co., Springfield, Mass.
Thos. G. Laney, Lima, Ohio.

Emery Wheels.

New York Belting & Packing Co., Ltd., New York.
Pennsylvania Machine Co., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.

Emery Wheel Machinery.

Pennsylvania Machine Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.

Engineering Instruments.

Brandis Sons Co., Brooklyn, N. Y.
Queen & Co., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Connersville Blower Co., Connersville, Ind.
Cooke & Co., 163 Washington St., N. Y.
P. H. & F. M. Roots Co., Connersville, Ind.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petroleum.

Fairbanks, Morse & Co., Chicago, Ill.
Otto Gas Engine Works, Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Shipman Engine Co., Boston, Mass.

Engines, Portable.

Griffith & Wedge Co., Zanesville, Ohio.

Engines, Stationary.

Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Beckett Foundry and Machine Co., Arlington, N. J.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Cooke & Co., 163 Washington St., N. Y.
C. & G. Cooper Co. Mt. Vernon, Ohio.
Fairbanks, Morse & Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Pennsylvania Machine Co., Philadelphia, Pa.
Shipman Engine Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
Robert Wetherill & Co., Chester, Penn.

Excavators.

Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.
Goubert Mfg. Co., 32 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fire Arms.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Fireproof Building Material.

Central Expanded Metal Co., Pittsburgh, Pa.
Cincinnati Corrugating Co., Piqua, Ohio
Berlin Iron Bridge Co., East Berlin, Conn.
Clay Shingle Co., Indianapolis, Ind.
Edward Darby & Sons, Philadelphia, Pa
Empire Fire Proofing Co., Pittsburgh, Pa.
Geo. T. McLauthlin & Co., Boston, Mass.
Henry Maurer & Son, 420 E. 23d St., N. Y.
New York Metal Ceiling Co., 21st St. and 13th Ave., N. Y.
Pioneer Fireproof Construction Co., Chicago Ill.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
Cooke & Co., 163 Washington St., N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.

Foot and Hand Presses.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Forgings.

Billings & Spencer Co., Hartford, Conn.

Furnace Builders.

Griffith & Wedge Co., Zanesville, Ohio.
Julian Kennedy, Pittsburgh, Pa.

Furniture.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

Egan Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
C. B. Rogers & Co., Norwich, Conn.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Lukenheimer Co., Cincinnati, Ohio.
Pancoast & Rogers, 22 Platt St., New York.

Gages, Steam.

Crosby Steam Gage and Valve Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Gages, Speed

Geo. T. McLauthlin & Co., Boston, Mass.

Gear Cutters.

E. Horton & Son Co., Windsor Locks, Conn.
E. W. Bliss Co., Brooklyn, N. Y
Pennsylvania Machine Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stiles & Parker Press Co., Brooklyn, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Chester Steel Castings Co., Philadelphia Pa.
Dayton Globe Iron Works Co., Dayton, Ohio.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates and Hearths.

Samuel H. French & Co., Philadelphia, Pa.
Edwin A. Jackson & Bro., 50 Beekman St., N.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Process Twist Drill Co., Taunton, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y,
Tanite Co., Stroudsburg, Pa.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hangers.

SEE PULLEYS, ETC.

Hardwood Floors.

E. B. Moore & Co., Chicago, Ill.

Hardware Manufacturers.

L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Cooke & Co., 163 Washington St., N. Y.
P. H. & F. M. Roots Co., Connersville, Ind.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Boynton Furnace Co., 207 Water St., New York.
Broomell Schmidt & Co., Limited, York, Pa.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
H. B. Smith Co., 137 Center St., N. Y.
S. Wilks Mfg. Co., Chicago, Ill.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
M. C. Bullock Mfg. Co., Chicago, Ill.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Volney W. Mason & Co., Providence, R. I.
J. S. Mundy, Newark, N. J.
Pelham Machine Works, 416 W. 26th St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.

Hod Hoisting Machinery.

Pelham Machine Works, 416 W. 26th St., N. Y.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill

Hose, Steam and Fire.

Crosby Steam Gage and Valve Co., Boston, Mass
Home Rubber Co., Trenton, N. J.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.

Hydraulic Machinery.

Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice Elevating and Conveying Machinery.

Gifford Brothers, Hudson, N. Y.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Crosby Steam Gage and Valve Co., Boston, Mass.
Queen & Co., Inc., Philadelphia, Pa.

Injectors.

Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
Merchant & Co., Philadelphia, Pa.
The Okonite Co., Limited, 13 Park Row, N. Y.

Iron Working Machinery.

E. W. Bliss Co., Brooklyn, N. Y.
W. F. & J. Barnes Co., Rockford, Ill.
Billings & Spencer Co., Hartford, Conn.
Bradford Mill Co., Cincinnati, Ohio.
Dwight Slate Machine Co., Hartford, Conn.
Fox Machine Co., Grand Rapids, Mich.
E. Horton & Son Co., Windsor Locks, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Providence, R. I.
D. E. Whiton Machine Co., New London, Conn.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.

Lamps, Electric.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa

Lathes.

E. W. Bliss Co., Brooklyn, N. Y.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 115 Broadway, N. Y.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Lunkenheimer Co., Cincinnati, Ohio.
Wm. Powell Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.

Machine Knives.

Fox Machine Co., Grand Rapids, Mich.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

W. F. & J. Barnes Co., Rockford, Ill.
Billings & Spencer Co., Hartford, Conn.
Bradford Mill Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cooke & Co., 163 Washington St., N. Y.
Dwight Slate Machine Co., Hartford, Conn.
Egan Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
E. Horton & Son Co., Windsor Locks, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
New Process Twist Drill Co., Taunton, Mass.
Robert Poole & Son Co., Baltimore, Md.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Providence, R. I.
D. E. Whiton Machine Co., New London, Conn.

Mantels.

Samuel H. French & Co., Philadelphia, Pa.

Mathematical Instruments.

E. L. Deane, Holyoke, Mass.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Merchant Steel.

Chester Steel Castings Co., Phila., Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y

Meters, Electric.

General Electric Co., 44 Broad St., N. Y

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.

Fox Machine Co., Grand Rapids, Mich.

Mining Machinery.

American Well Works, Aurora, Ill.
Beckett Foundry and Machine Co., Arlington, N. J.
Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Mining Screens.

Beckett Foundry and Machine Co., Arlington, N. J
Earle C. Bacon, 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.

Brush Electric Co., Cleveland, Ohio.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Standard Thermometer Co., Peabody, Mass.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Oil Cups.

Lunkenheimer Co., Cincinnati, Ohio.
Wm. Powell Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.

Packing.

Home Rubber Co., Trenton, N. J.
Garlock Packing Co., Palmyra, N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.

Paints.

Joseph Dixon Crucible Co., Jersey City, N. J.
Samuel H. French & Co., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.

Paper Mill Machinery.

Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Moore & White Co., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Pattern Makers' Machinery.

Fox Machine Co., Grand Rapids, Mich.

Penstocks.

Atlantic Works, East Boston, Mass.

Perforated Metal.

Merchant & Co., Philadelphia, Pa.

Photographic Supplies.

Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pile Drivers.

Bucyrus Steam Shovel & Dredge Co., S. Milwaukee, Wis.

Pipe and Boiler Coverings.

Keasbey & Mattison Co., Ambler, Penn.

Pipe Casings, etc.

Pancoast & Rogers, 22 Platt St., New York.

Pipe, Cast Iron.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Ohio Pipe Co., Columbus, Ohio.
Pancoast & Rogers, 22 Platt St., New York.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.

National Pipe Bending Co., New Haven, Conn.

Pipe Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.

Pipe-Spiral Riveted.

Merchant & Co., Philadelphia, Pa.

Pipe, Wrought Iron, Line and Drive.

Morris, Tasker & Co., Philadelphia Pa.
Pancoast & Rogers, 22 Platt St., New York.

Planing Mill Machinery.

Egan Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.

Portable Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.

E. W. Bliss Co., Brooklyn, N. Y.
Long & Allstatter Co., Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Power Transmission, Electric.

General Electric Co., 44 Broad St., N. Y.

Presses, Hydraulic.

Fox Machine Co., Grand Rapids, Mich.
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Pressure Regulators.

Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Prospecting Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.

W. F. & J. Barnes Co., Rockford, Ill.

Pulleys, Shafting and Hangers.

Edw. P. Allis Co., Milwaukee, Wis.
Cooke & Co., 163 Washington St., N. Y.
Dayton Globe Iron Works, Dayton, Ohio.
Gifford Brothers, Hudson, N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Volney W. Mason & Co., Providence, R. I.
Moore & White Co., Philadelphia, Pa.
Robert Poole & Son Co., Baltimore, Md.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Geo. T. McLauthlin & Co., Boston, Mass.

Pumps and Pumping Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooke & Co., 163 Washington St., N. Y.
M. T. Davidson, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Thos. G. Laney, Lima, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
Holly Mfg. Co., Lockport, N. Y.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pump Governors.

Mason Regulator Co., Boston, Mass.

Punching and Shearing Presses.

E. W. Bliss Co., Brooklyn, N. Y.
Fox Machine Co., Grand Rapids, Mich.
Long & Allstatter Co., Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Quarrying Machinery.

M. C. Bullock Mfg. Co., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y
J. S. Mundy, Newark, N. J.
Pelham Machine Works, 416 W. 26th St., N. Y.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiators.

American Radiator Co., Chicago, Ill.
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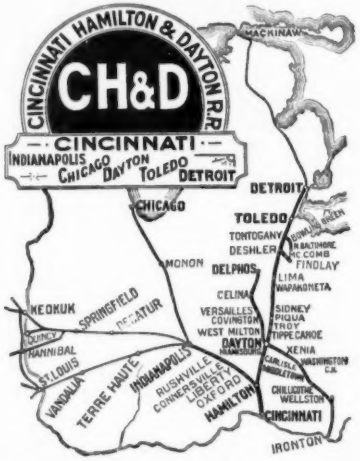

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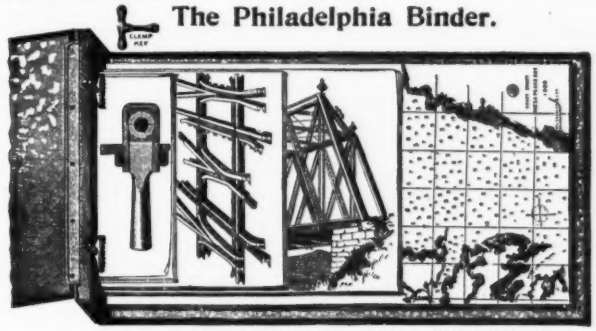

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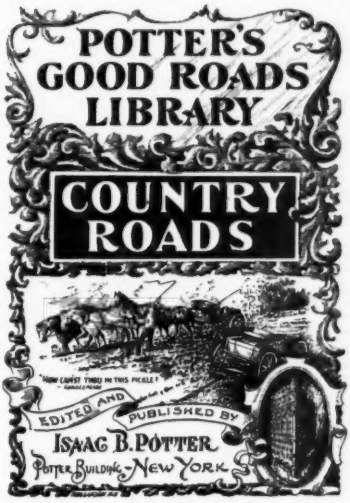

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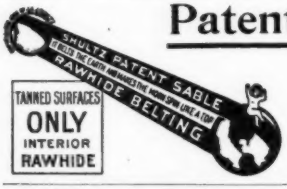

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IMPROVED MACHINERY

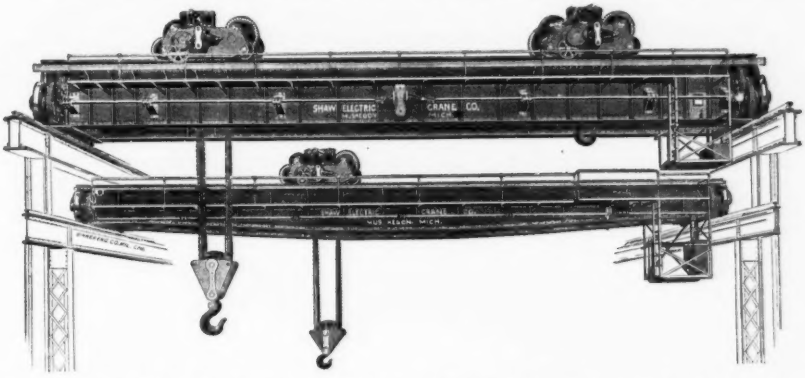
The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Notable Sales of Electric Cranes.

FOLLOWING the dullness of the past summer months in mechanical lines, it is cheering to note the evidence of returning activity which is indicated by the fact that on Aug. 9, 1894, Messrs. Manning, Maxwell & Moore, New York, made the following sales of the Shaw three motor electric traveling cranes, built by The Shaw Electric Crane Co., Muskegon, Mich., for whom they are the sole agents: Pittsburgh Tin Plate Works, a 12-ton crane; the celebrated steam pump establishment of Henry R. Worthington, a 30-ton crane; and the Midvale Steel Co., Philadelphia, a 40-ton double trolley crane. They further advise us that the crane for the Worthington Pump Works is to supplement a Morgan Electric Crane, and that the order from the Midvale Steel Co. is especially satisfactory in view of the fact that they now have in their works one 80-ton, two 40-ton and two 20-ton Shaw cranes.

These sales show that economy in handling materials is a great factor in these times of depression, and that the leading manufacturing establishments are availing themselves of the very latest improvements in the way of labor saving machinery. And they further show that while the vast majority of manufacturers have been waiting and and grumbling about dull times, wide-awake business men, *with a good thing to sell*, have been pushing for business—with the usual result which waits on business enterprise.

In view of the notable character of these sales, we take pleasure in presenting herewith a drawing of one of the cranes already at work in the Midvale Steel Co.'s factory. It is operated by three independent electric motors, one for actuating the hoisting mechanism, one for moving the crane up and down the shop, and one for traversing the trolley backward and forward on the bridge. They are frequently made with two trolleys on one bridge, an arrangement especially adapted for handling locomotives or any long work which it is inconvenient or dangerous to sling by its center. In this case each trolley carries independent motors for the hoist and traverse movements, and is absolutely independent of the other, although they may be run in unison, when desired.



All the movements of either the single or double trolley cranes may be in operation at the same time; each is independent of all the others,

and may be run at will at any desired speed not greater than its maximum. This last very valuable feature is attained simply by varying the position of the reversing levers. Whenever any reversing lever is in its mid position, the mechanism controlled by it is at rest; when the lever is moved from its mid position, the mechanism controlled by it begins to move, the direction and speed of the movement depending respectively on the direction in, and distance through, which the lever is moved by the operator.

One of the great advantages which these cranes possess over all others, is in the facility with which the speed of the load or any other movement may be gradually accelerated or retarded from zero to the highest limit of speed, or vice versa, or moved steadily at any desired rate, in the manner just indicated. This gives great smoothness of action and accuracy of control.

Another Pushing Business.

FURTHER evidence of live business methods, in line with the notable sales above recorded, is furnished again this month by The F. D. Cummer & Son Co., Cleveland, Ohio. Writing us as to the progress they are making in introducing the Cummer Dryer, which was illustrated and described in this department a few months ago, they say, under date of July 23—the very middle of summer and when the croakers were grumbling as never before over the dull times, the tariff fight, or some other loafing excuse:

On the 21st inst. we made the Rathbun Co. of Deseronto, Ontario, a proposition to replace their present hot air apparatus with one of ours. This morning we received the following telegram, dated Deseronto, Ont., July 23d: "Proposition twenty-first received. Please hurry tunnel drying system all possible. Have written. (signed) The Rathbun Co."

We feel quite elated over receiving this order, as it will take the place of a plant furnished by one of the largest manufacturers in the United States.

We are also glad to say that the sales for our standard style "A" dryers continue to be good, and report as new business:

One dryer for clay, Fairfield, Ia.
" " " sand, Utica, Ill.
" " " carbonate of soda, Keeler, Cal.
" " " phosphate, Tebbessa, Algeria, Africa.
" " " infusorial earth, Baltimore, Md.
" " " gypsum rock, Oakfield, N. Y.

The complete explanation for this fine showing of new business in the dull summer months, lies in the fact, not only that the firm has an excellent dryer, but especially that every member of the firm and every one of their salesmen and agents has been kept actively and continuously at work. It was only the other day that Mr. W. M. Cummer was cabling orders from London, and it will be observed that the above sales range from California in the West to New York in the East, and from Iowa, North, to Maryland, South, with an incidental sale in far-away Algeria. Meanwhile the office force is kept busy pushing the correspondence and advertising—as shown by the fact that in the above letter to us they enclose a *fac simile* testimonial letter from E. Brovender, Supt., Warners, N. Y. which reads thus:

The two Hot Air Furnaces supplied for the Empire Portland Cement Co. by you are giving us excellent results. They are extremely economical in consumption of fuel as compared with the steam drying systems that I have been familiar with. No indirect system of heating or drying can compare with your hot air system.

And in the matter of their advertising, we will perhaps be pardoned for reproducing here the following brief correspondence which explains itself:

From F. D. Cummer & Son Co., Cleveland, O.:

"We are pleased with the results we have received from our small card in THE ENGINEERING MAGAZINE, and although this is a very poor time (Dec. 27, 1893) to increase advertising expenses, we would feel like changing it to a quarter or a half page, if you can make us a satisfactory price. Let us hear from you."

The same firm, in a subsequent letter to Frazer & Chalmers, Chicago:

"We look upon the money we have expended with THE ENGINEERING MAGAZINE as the best investment we have ever made in the advertising line and from now on, will appear with a half page 'ad.'"

It may be set down as an axiomatic truth, that a money-saving device, backed by business push and an intelligent use of printer's ink, will sell in all sorts of seasons—good or bad; but pure gold can't sell itself!

A Large Lumber-Drying Apparatus.

THE seasoning of lumber by the Progressive "Fan" systems of dry kilns is so efficient and economical that very large kilns of this sort are no longer uncommon. It is seldom in very large dryers that anything but a ¾ housing fan is employed. With this style of fan, the horizontal type of engine is used for driving and is readily accessible for oiling and repairs on account of the lower scroll of the fan being underground, bringing the engine down low. The Menasha Wooden Ware Co., of Menasha, Wis., who employ in their plant over a dozen dryers, find it

impossible to install a ¾ housing fan, for the reason that their kilns for the most part are located on piles driven into low marshy ground, in fact, close up to the water's edge, to facilitate handling the green lumber. The largest full housing fan ever employed for a lumber dry kiln was purchased by them of the Buffalo Forge Co., Buffalo, N. Y., about three months ago. The fan stands 150" in height, and is supplied with a direct acting double 10 × 10 cylinder engine, the working parts being entirely enclosed. A heater containing 14,000 lineal feet of 1" pipe is used in conjunction with the fan. Although this engine runs continuously, and upon a foundation anything but solid, highly satisfactory results are reported. The firm have, in fact, just ordered of the Buffalo Forge Co. a duplicate of the above plant, and in their letter they say: "From the fact of our giving you a further order, you can imagine that we are pretty well pleased with the apparatus that we now have, taking into consideration the special inducements which have been offered us by your competitors."

The apparatus referred to is the first "Buffalo" kiln installed into their immense works, although they have been using the "Fan" system for a number of years.

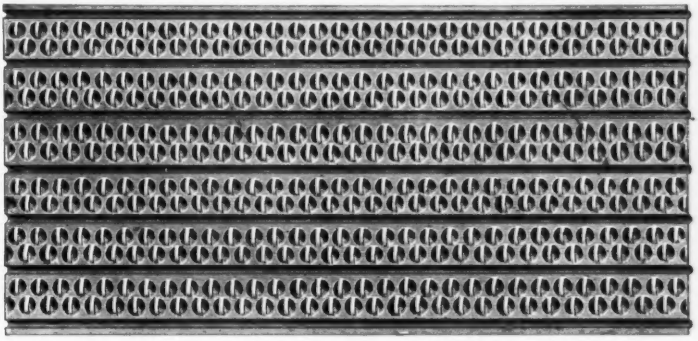
The "Piqua" Metallic Lath.

THE facility with which mechanical methods are superseding hand labor in the production of building materials, finds a happy illustration in the latest form of a steel lath to take the place of the old-fashioned quick-burning wood lath.

The Cincinnati Corrugating Co. with Rolling Mills, Corrugating Works and Offices at Piqua, Ohio, have recently perfected and are now placing upon the market a new and improved form of Steel Lath, shown in the accompanying engraving, for which they claim a number of improved features.

The material used is of the best grade of steel, in sheets 27¼ inches wide by 48 inches long, each sheet covering exactly one square yard of surface. These sheets are traversed lengthwise at intervals of 3¼ inches, by ¾ inch corrugations, thus providing great rigidity and stiffness to the entire sheet.

Between these corrugations, as will be noted upon reference to the illustration, are formed a series of slots at right angles to the corrugations, the metal on either side of the slot being depressed into cup like shape, into which the mortar or plaster easily slides, and passing through forms a "key" of extraordinary strength and perfection, besides obviating entirely the useless and expensive waste of plaster incurred when other types of metal or wood lath are employed.



THE "PIQUA" METALLIC LATH.

The "Piqua" Metallic Lath requires no stretching, stiffening pieces, nor staples for securing it to the frame work, common nails only being used for attaching it in position.

While this Lath is used quite largely in buildings of wooden construction, still it is principally used in strictly fire-proof buildings, in connection with iron beams and furring; and it is here that the rigidity and stiffness formed by the corrugations make it especially valuable, for the reason that the studding can be placed at least two feet apart, making thereby a great saving in the cost of studding. Where this Lath is used in connection with iron, the usual method is to wire it into place, the cost of which is little, if any, more than the cost of nailing it to wooden studs.

It is especially adapted for Adamant or Patent Plaster, and the rapidity and ease with which it may be applied to round, square, or angular surfaces, together with the fact that it affords a much firmer holding surface for the plaster, with its fire proof qualities, commend it to all Architects, Builders and owners of buildings.

The "Spence" Hot Water Heater.

THE following circular letter has recently been issued to all the customers of the American Boiler Co. and at their request it is published here because in recent years our readers have been made so familiar with the points of excellence in the "Spence" boiler, viz.:

Dear Sir:—

Our notice has recently been called to the fact, that some makers of hot water heaters are employing all the wit they possess to put on the market heaters that have a similar external appearance to the *original genuine* "Spence," which we own and control; and are sending out jaunty letters as a disguise. We most emphatically say our company own and control all the original United States patents covering the most essential features in the internal construction of the *genuine "Spence boilers,"* pertaining to the water post which makes each section independent of the other. In no other boiler manufactured and sold that we know of, is this possible. We shall not try to deceive any of the trade by over-rating any of the large line of boilers we manufacture and sell, as we are working strictly upon the basis of maintaining the already established reputation we enjoy. We are not merely doing business to-day, but expect to continue in the market for a good many years. If you accept the desultory letters sent out by new beginners, you must take your chances on results, as it takes years of experience to overcome certain inherent defects in the construction of an article like water boilers. After a long experience of twenty-five years, during which time we have seen a great many manufacturers of boilers pass into a state of "innocuous desuetude," it prompts us to know we shall continue to stand pre-eminently at the head of the list and want to merit a continuance of your kind patronage and confidence. Don't hesitate to write us regarding any details in connection with steam or hot water heating as it is a great pleasure for us to co-operate with you to our mutual advantage.

Yours very truly,
AMERICAN BOILER COMPANY.

A Record in Rock-Drilling.

THE efficiency of the modern rock drill, when operated by improved compressed air apparatus, finds striking illustration in the following record of actual work which has been reported to us by the Ingersoll-Sergeant Drill Co., New York.

The information is taken from a letter from Messrs. Chas. F. King & Co., the contractors who are driving the Jeddo Tunnel, at Ebervale, Luzerne Co., Pa., who say:

"We are doing some tall work in this tunnel—at least we think we are. In the Butler end we cleaned up in May 301½ feet, and in June 305 feet of heading. At Ebervale heading we cleaned up in May 308 feet, and in June 300 feet. You will agree with us that this is exceptionally good work, especially at Butler, where the compressed air is carried two miles. We expect to get a hole through about the middle of August.

"As you know we are driving the tunnel full section 7 × 11 feet with two 3¼" Ingersoll-Sergeant rock drills in each heading, by two shifts of men, each shift working 10 hours per day.

"Air to run the drills, pumps, etc., is supplied by two Ingersoll-Sergeant 'Straight Line' air compressors, one being 24 × 30" cylinders, another 20 × 24, and a smaller one is held in reserve for emergencies."

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Day-Moberg Electric Company, Boston, Mass.—The Jupiter Storage Battery. 8 p. [A brief criticism of storage batteries, with description of battery.]

The Odorless Excavating Company, Boston.—Sanitary Pumps and Apparatus. [Description of apparatus for odorless excavation of vaults and cesspools.]

Charles A. Schieren & Co., New York.—Patent Perforated Electric Leather Belting. 32 p. [Descriptive price-list, with rules for measurement and points on use of leather belting.]

The Lodge and Shipley Machine Tool Company, Cincinnati.—Machine Tools. 43 p. [Neat and carefully prepared description of machine-tools for rapid production of lathe-work.]

Reading Foundry Company, Limited, Reading, Pa.—Cast-Iron Pipe. 39 p. [In addition to price-list of pipe and castings, contains valuable rules and tables carefully edited.]

F. E. Reed & Co., Worcester, Mass.—Lathes and Machine Tools. 47 p. [A handsome publication, with full description of improved machine tools.]

The Verona Tool Works, Pittsburgh.—Blue Prints. 33 p. [Unique trade publication with full descriptions and diagrams of railway trackmen's tools.]

American Tripoli Company, Carthage, Mo.—General Catalogue. 20 p. [Brief description of tripoli and the uses to which it is put.]

[*For additional catalogues see "Current Technical Literature," page 916.*]

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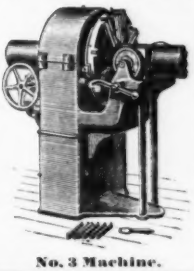

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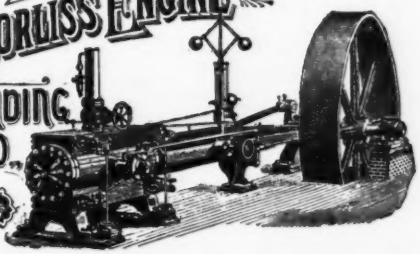

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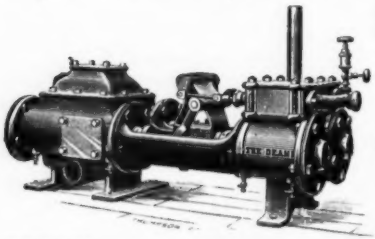

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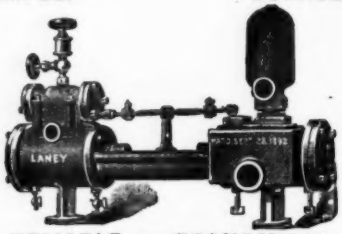

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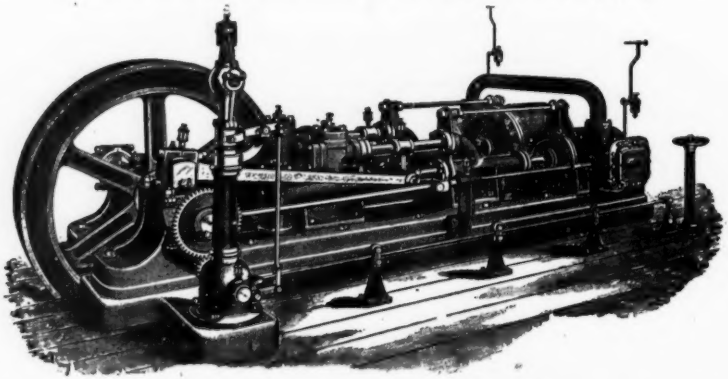

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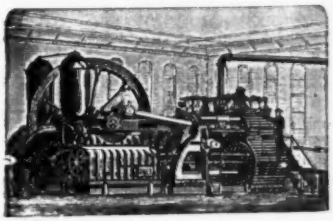

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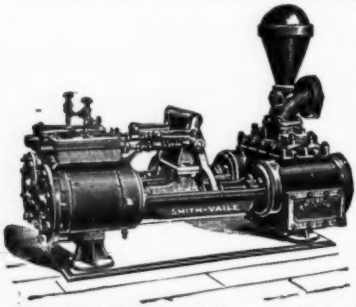

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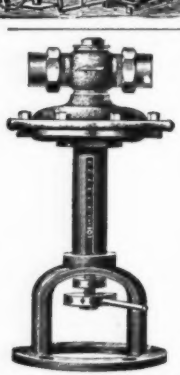

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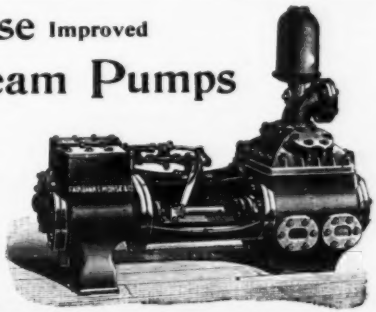

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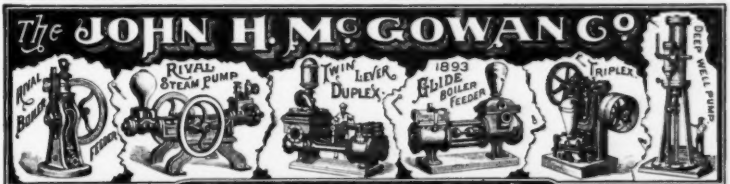

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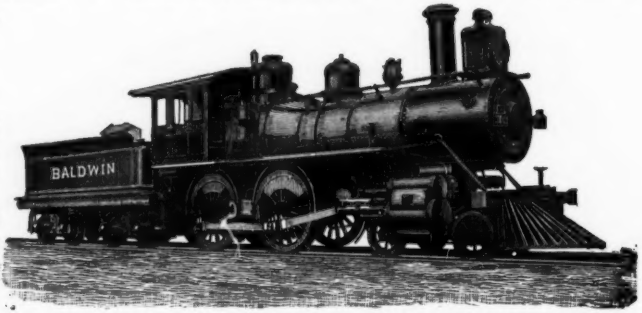

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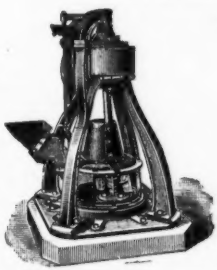

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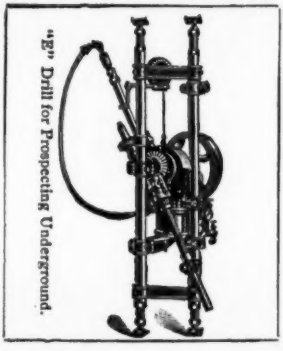

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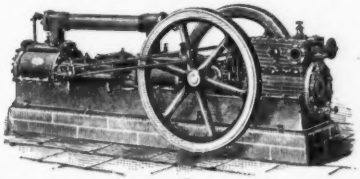

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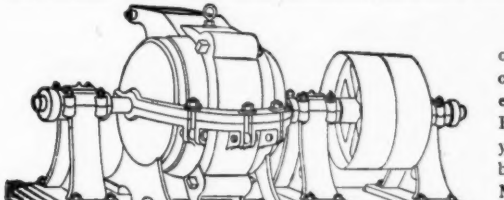

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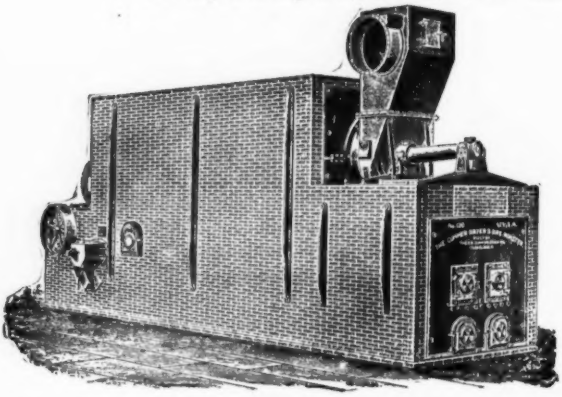

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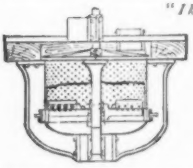

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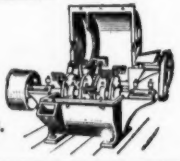

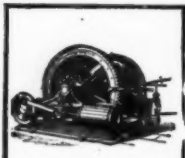

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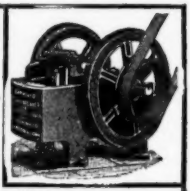

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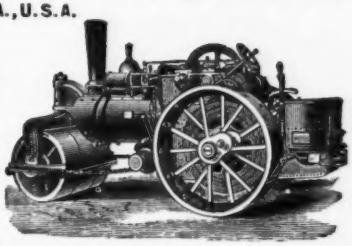

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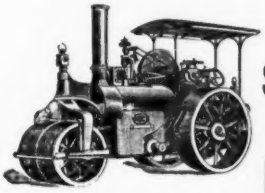

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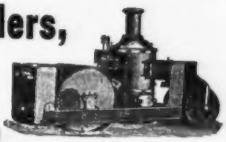

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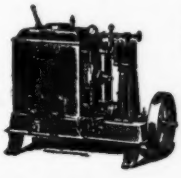

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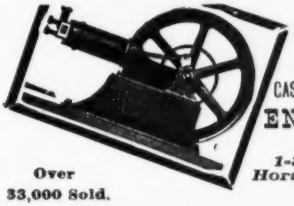

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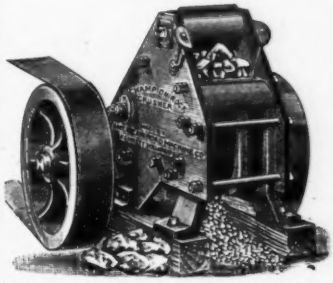

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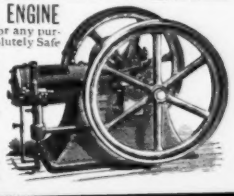

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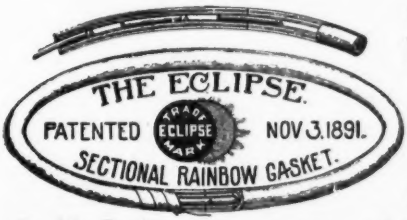

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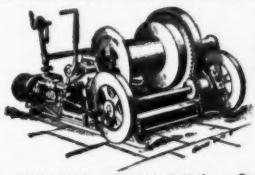

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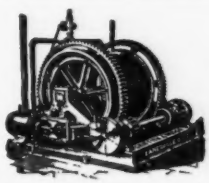

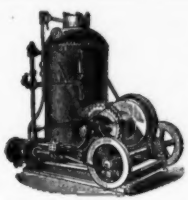

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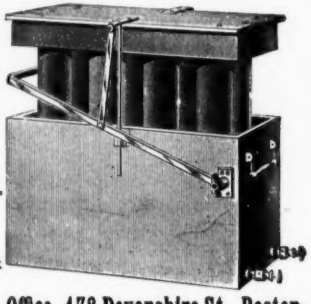

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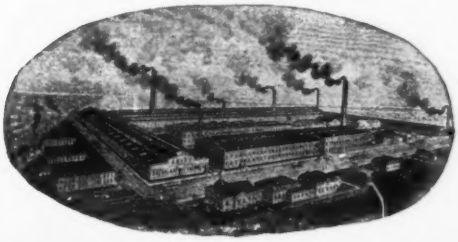

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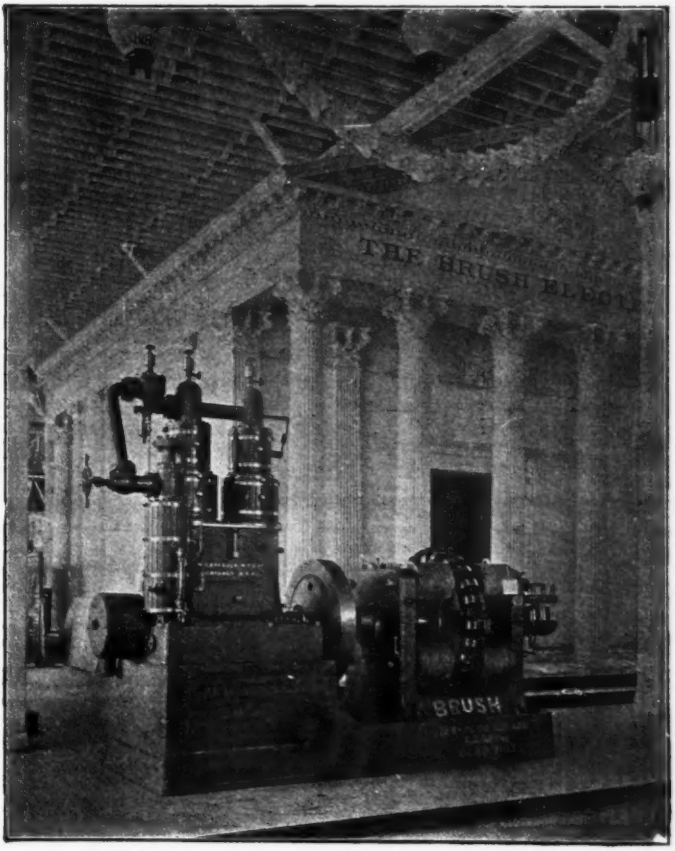

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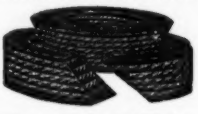

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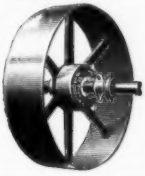

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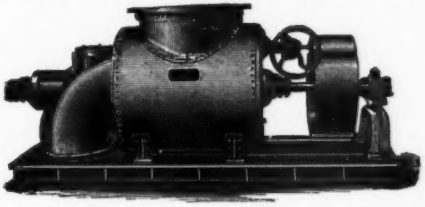

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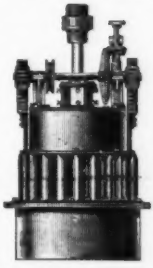

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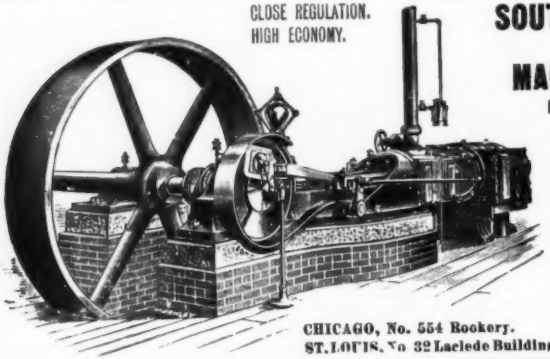

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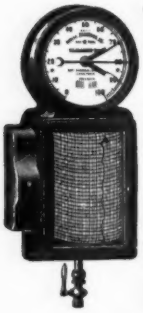

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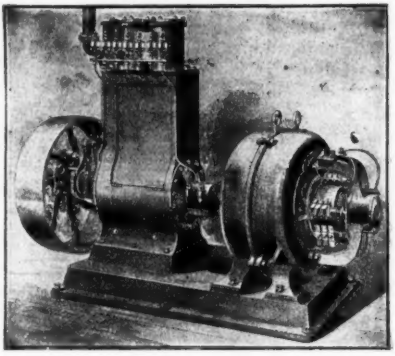

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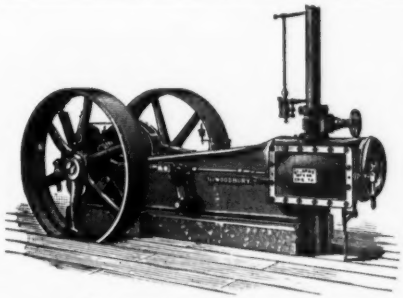

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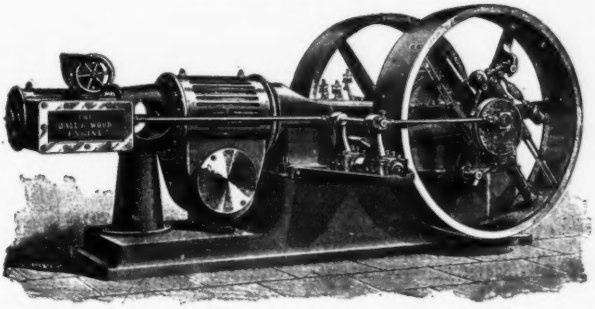

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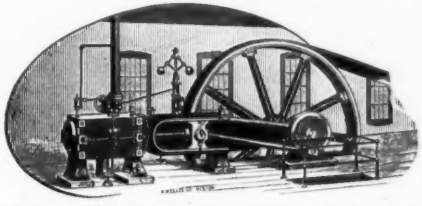

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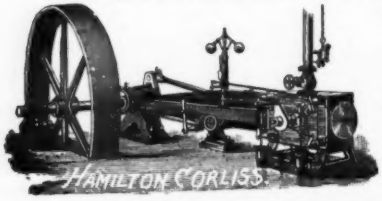

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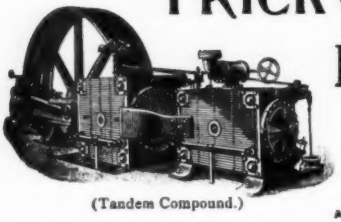

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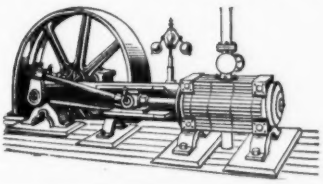

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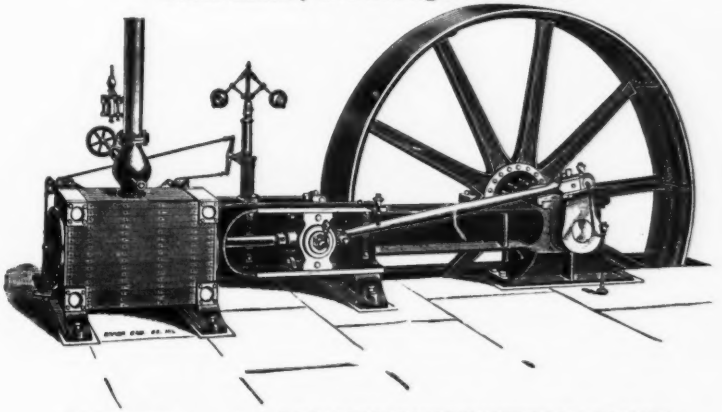

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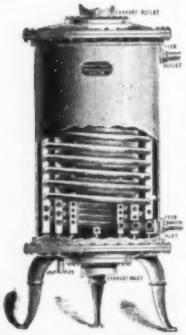

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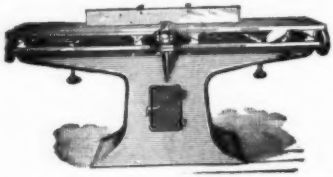

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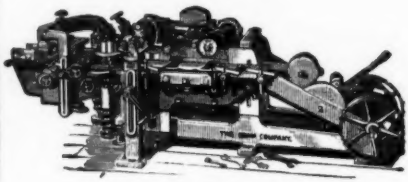

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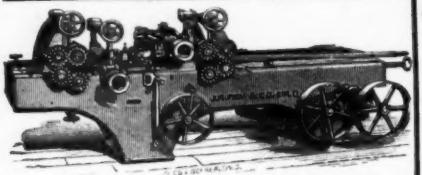

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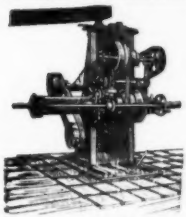

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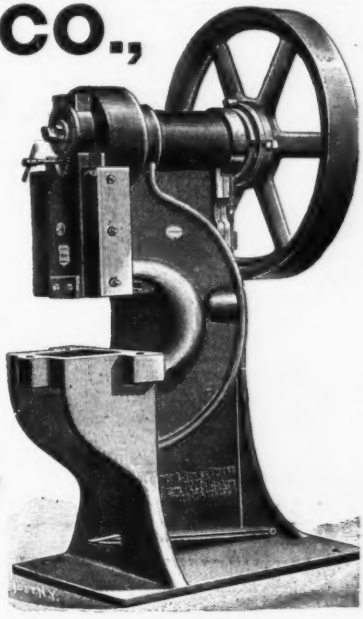

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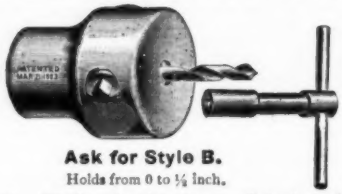

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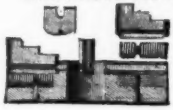

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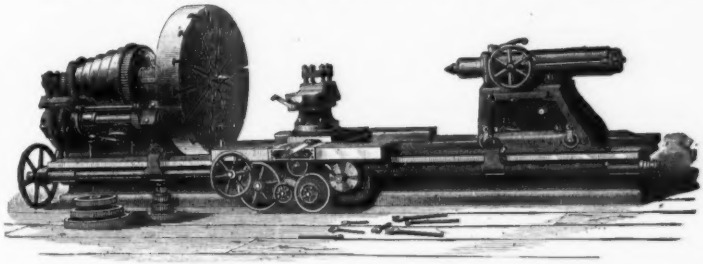

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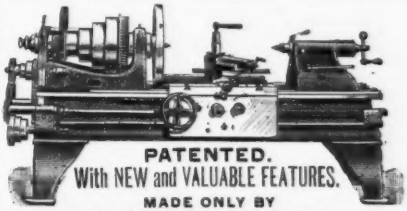

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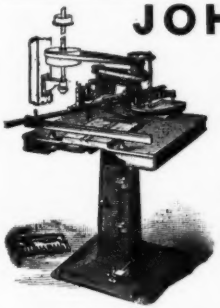

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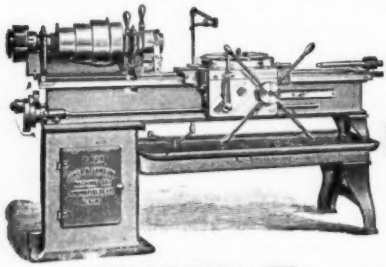

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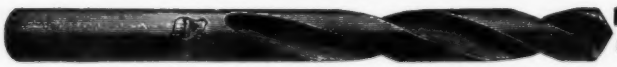

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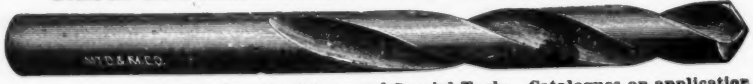

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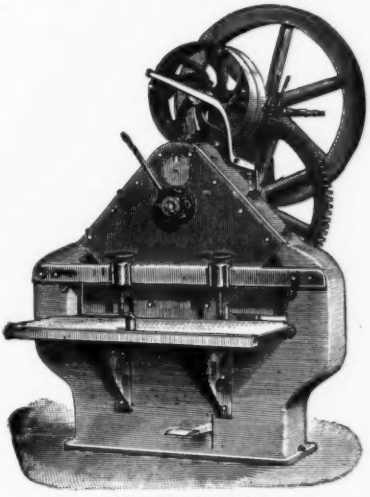

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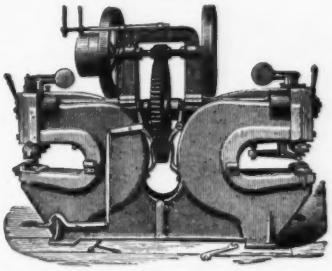

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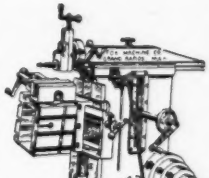

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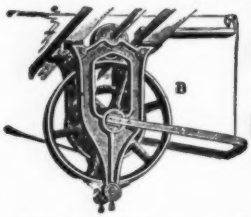

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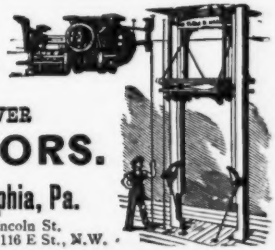

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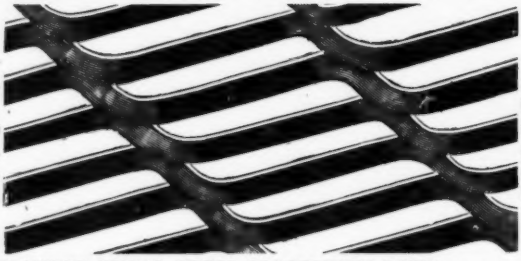

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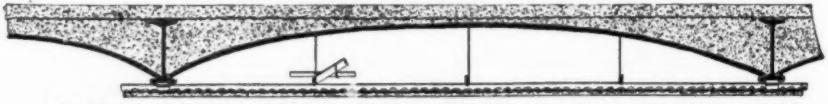

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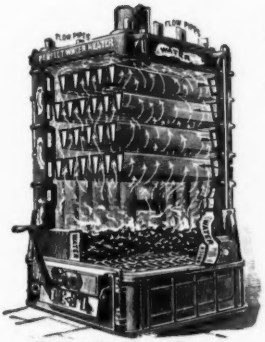

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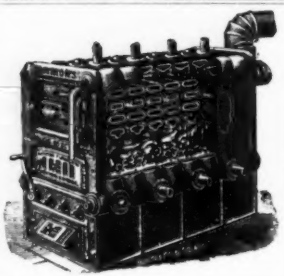

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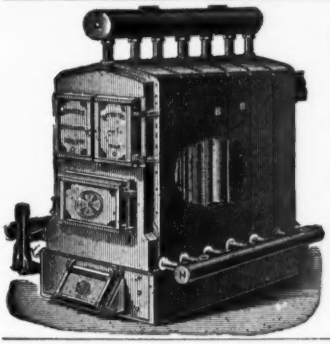

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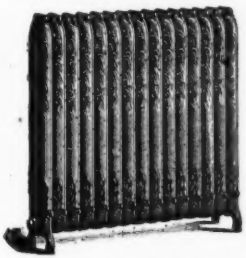

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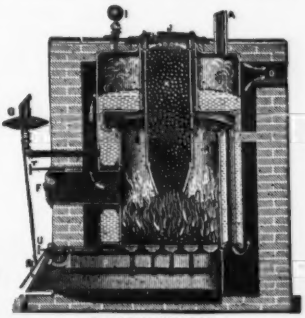

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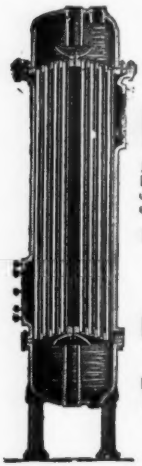

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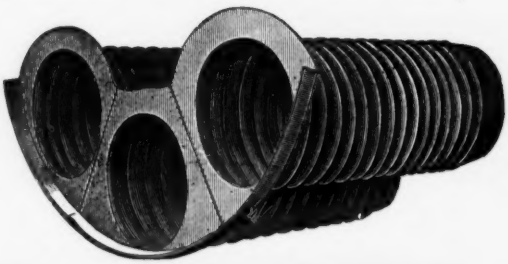

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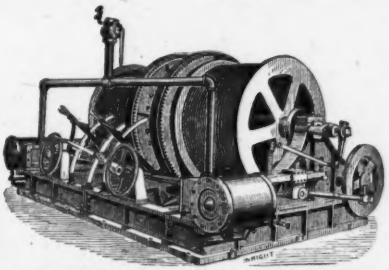

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